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A TEXT BOOK

OF

ANATOMY,

AND

GUIDE IN DISSECTIONS,

FOR THE USE OF

STUDENTS OF MEDICINE AND DENTAL SURGERY.

BY

WASHINGTON R. HANDY, M. D.

PROFESSOR OF ANATOMY AND PHYSIOLOGY IN THE BALTIMORE COLLEGE OF DENTAL SURGERY; LATE PROFESSOR OF ANATOMY AND OPERATIVE SURGERY IN WASHINGTON UNIVERSITY, BALTIMORE.

WITH TWO HUNDRED AND SIXTY-FOUR ILLUSTRATIONS.

PHILADELPHIA:
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TO

CHAPIN A. HARRIS, M.D.

PROFESSOR OF THE PRINCIPLES OF DENTAL SURGERY IN THE BALTIMORE COLLEGE,

AS AN ACKNOWLEDGMENT FOR

UNTIRING DEVOTION IN THE ADVANCEMENT OF DENTAL SCIENCE,

AND AS A

TESTIMONIAL OF REGARD FOR GREAT PRIVATE WORTH,

THIS WORK

IS RESPECTFULLY INSCRIBED,

BY HIS GRATEFUL FRIEND,

THE AUTHOR.

PREFACE.

The author is aware of the many valuable works on Anatomy adapted to the Student and Practitioner of Medicine; but he does not know of one that has been arranged with a view also to the claims of the Student and Practitioner of Dental Surgery. To prepare a work, therefore, adapted alike for the Dental as well as the Medical Student—one which directs *special attention to the Mouth*, showing step by step the important anatomical and physiological relations which it has with each and all the organs and functions of the general system—forms one of the leading objects of the present undertaking.

Dental Students are slow to see and feel the necessity of a knowledge of any more of Anatomy than so far as the Teeth and their immediate connections in the mouth are concerned, and to go beyond this is thought rather a waste of time, and entirely foreign to the practice of the profession they design to pursue. No work on Anatomy has taken very particular pains to teach them any better. To correct this false and dangerous sentiment, and to demonstrate the necessity of anatomical knowledge to the scientific, skillful, and successful Dentist, equally with that of the Physician, forms the second and chief reason which has induced the author to write the present work.

The *Plan* of the work, after giving a general outline of *Organization*, divides the subject into four parts:

The first part teaches the *Alphabet* of Anatomy, or the Elementary Tissues of the Body, whose varied combina-

tion constitutes the Anatomical Language, or the various organs composing the General System.

The second part begins with the Head, and describes its organs, as far as possible, in their functional order and dependency; thus combining the *Anatomy* and *Physiology* of the several organs, however various, concerned in any particular function—a plan found to be most interesting, and, it is believed, at the same time most practical and useful. This part is then made complete by showing the Anatomical and Physiological relations of the Mouth with the different parts of the Head.

The third part, embracing the Trunk, is examined in the same physiological order, and completed in the same manner, by demonstrating the *Relations* of the *Mouth* with its several organs, viscera and functions.

The fourth part comprises the Extremities, which do not admit of the same kind of arrangement so readily, and are demonstrated in the ordinary way.

The author has freely consulted the best sources of authority, and here desires to make his acknowledgments to the works of Wistar by Pancoast, Horner, Smith's Anatomical Atlas, Bell by Godman, Quain, Wilson, Sharpy and Quain by Leidy, Cloquet, Cruveilheir by Pattison, Von Behr's Hand Book of Human Anatomy, The Dublin Dissector, Solly on the Human Brain, Knox's Manual of Anatomy, Holden's Manual of Dissections, Morton's Human Anatomy, Nasmyth, Goodsir, Owen, Harris, Tomes, Carpenter's Human Physiology, Carpenter's Principles of General and Comparative Physiology, Muller by Bell, Magendie; and most especially does he return his thanks to Professors Harris and Piggot for their kind assistance and valuable suggestions, while the work was passing through the press.

The Index, it will be perceived, has been arranged somewhat differently from the one in common use, that is to say, instead of finding all the bones arranged under the one head of bones, muscles under the one head of muscles, arteries under the one head of arteries, &c., each bone, muscle, artery, &c., will be found under its proper alphabetical head.

W. R. HANDY.

BALTIMORE, OCT. 19, 1853.

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LIST OF ILLUSTRATIONS.

Errata.—A few typographical errors have occurred in the printing of the work, which the attentive reader will be able to correct.

INTRODUCTION.

HISTORY OF ANATOMY.

All that we propose, under the present head, is simply to give a very brief outline of the Art of Dissection, for the purpose of showing, by way of contrast, its past and present state.

The *Art of Dissection* appears to be of great antiquity, it being the custom to sacrifice animals to the Deity, some parts being set aside for the sacrifice, and others for the use of the priests. It hence became necessary to discriminate, or distinguish the one from the other. This kind of knowledge, however, belonged to Comparative Anatomy, and at that day was mostly confined to the butchers.

It is supposed that the cruel custom of human sacrifices originated the first information we have of the human body; for in such cases it was necessary that some knowledge of the internal structure of the human frame should be acquired by the priests, that they might properly conduct such ceremony.

The first attempt at making Anatomy a science, is ascribed to *Pythagoras*, and *Thales* of *Miletum*, about 700 years before Christ, who, we are told, made it a part of their studies. Empedocles, about 100 years after this, showed considerable Anatomical knowledge, especially in reference to the *cochlea* and *tube* of the ear.

The first who dissected animals, with a view to learning their internal structure, was Alcmæon, a disciple of Py-

thagoras. But it is to Hippocrates, who is styled the father of medicine, that we are directed to look, as being the possessor of all the Anatomy known in his day, which was about 500 years before Christ. This knowledge, if such it may be called, though it abounded in errors, and in a great measure necessarily so, from the dissections being mostly confined to inferior animals, and from the superstitions of the age, and insuperable obstacles constantly opposing human dissections: we say, in view of all this, we cannot refrain uniting in the language of an author, "that the perseverance and acquirements of this great man, the ornament of the medical profession, cannot be sufficiently admired." A few specimens of his Anatomical knowledge will here suffice. The left ventricle of the heart he supposed the seat of the soul. The arteries he thought conducted the spirits. The liver he believed to be the fountain of the blood, and the root of the veins. The heart and lungs he supposed received part of our drink. The auricles were believed to serve the purpose of a fan; and no distinction was made between arteries, veins, nerves and tendons.

After Hippocrates, the study of Anatomy seemed to be chiefly confined to the two schools of *Athens* and *Alexandria*. To the former belong the names of Socrates, Plato, Xenophon, Aristotle and Theophrastus. And although their attention was principally directed to the study of Philosophy, yet a knowledge of Anatomy was not overlooked, though the examination of bodies was very much restricted.

In the Alexandrian school, however, Anatomy greatly flourished. It received the protection, favor, and presence of the Ptolemies. Anatomy was here publicly taught. Dissections of human bodies were made, and we are informed that kings were sometimes present at them. *Herophilus* and *Erasistratus* were the distinguished masters of Anatomy in this school. We are told that they dissected several hundred bodies, and were especially famous for their productions in Neurology.

From *Herophilus* and *Erasistratus*, to *Galen*, embracing a

period of 500 years, the names of *Asclepiades, Rufus Ephese-us*, and *Celsus*, stand most prominent. The two latter gave the names and localities to many parts of the body. *Claudius Galenus* or *Galen* appeared and flourished about the close of the second century. He was considered one of the most remarkable and learned men that ever lived. He applied himself especially to the investigation of Anatomy, but, unfortunately, his descriptions were mostly taken from the brute creation. In his works, *Anatomy* is made to occupy a prominent and methodical place, and for 1500 years his name and influence reigned supreme, in spite of all his errors; so much so, that it was considered the very height of medical folly even to suspect, and a far more unpardonable presumption to call in question and attempt to correct any of his opinions.

A treatise "on the nature of man," is recorded as being the production of *Nemesius*, Bishop of Emissa, who wrote about the end of the fourth century, his most prominent Anatomical claim being the discovery of the use of the bile. From the period of Galen to the 16th century, Anatomy, with every other kind of learning, was on the decline. During this long lapse of what has been very significantly styled the *Dark Ages*, very little or no improvement was made. After the destruction of Alexandria, learning, as much as was left, was introduced among the Arabians, and they applied themselves to the study of "physic;" but, as their law, like that of the Jew, prohibited dissections, of course they could make but little improvement.

In the 11th century, the school of Salernum, in Sicily, was established, and obtained considerable reputation. But owing to the ignorance and superstition of the times, and from its being viewed as a "crime" to dissect a human body, this school did little more than teach the dogmas of the Arabian doctors.

About the close of the 12th century, *Abdollalliph* distinguished himself in osteology, by exposing many of the errors of Galen in this department.

In the commencement of the 14th century, *Mundinus* is represented as the first European author who insisted upon dissections, and whose system of instruction was of so high repute, as to be taught for years in the schools. Even in the University of Padua, the Professors were obliged, by a law of the College, to make this system their text-book.

Towards the close of the 15th century, *Jacobus Berengarius Carpus* revived dissections, and published two Anatomical works, one of which was simply a commentary on Mundinus.

The 16th century teems with improvements and discoveries in anatomy, from men of the most exalted talent, untiring industry, and self-sacrificing devotion to this, their favorite pursuit. Italy for a long time seemed to be the sole theatre of Anatomical knowledge. About the year 1536, however, John Guinterius, who had been a teacher of Anatomy for several years in Paris, published a work entitled "Anatomicæ Institutiones," in which, it is said, he has given a pretty full and accurate description of the muscles.

But it is most especially to that great man, *Andreas Vesalius*, of Brussels, that we are to look for the restoration of Anatomy. He was the real and true *reformer*, the bold and unflinching Luther in practical Anatomy, the untiring zealot in dissections, and the prompt and fearless exposer of error. Hence, he very soon brought himself into trouble, by daring to expose the numerous errors of Galen and others, of the existence of which his dissections at every step clearly convinced him. He published his *Anatomy* in 1543, and his descriptions of the bones and muscles are stated to be very minute, and not much surpassed even by modern authors. His figures are described as master-pieces of painting. Vesalius attended Lectures in Paris, to which he had been invited by the Professors of the University. He devoted himself to dissections, by clandestinely procuring bodies for that purpose, and in the proportion that he discovered

Galen's errors in Anatomy, in the same proportion did his veneration for that great man diminish, and this he did not fail openly to avow and publish. Immediately he had a host of enemies to encounter, and so hot was the opposition, that he was obliged to leave Paris. His criticisms on Galen were published when he was only 28 years of age, in consequence of which daring and impious opposition, as it was supposed, to the infallible Galen, all Europe seemed in arms against Vesalius. And what was most trying, his Preceptor, *Sylvius*, at Paris, was the most bitter among his opponents. Sylvius changed the name of Vesalius to that of *Vesanus* or *madman*. In defiance of all opposition, however, his reputation increased, and he was appointed Professor of Anatomy in the *University of Padua*, by the Republic of Venice, which chair he filled for seven years. He was also *first Physician* to the Emperor, Charles V, who kept him constantly at court.

Vesalius' work, "*De structura corporis Humani*," is said to have been published when he was but about 25 years of age. In 1561, *Gabriel Fallopius*, a pupil of Vesalius, distinguished himself. He was Professor of Anatomy in the University of Padua, and also author of an anatomical treatise under the title of "*Observationes Anatomicæ.*"

It was intended more as a supplement to the work of Vesalius, many of whose descriptions he corrects, which Vesalius it seems did not much like, and in consequence replied to his pupil.

In 1563, *Bartholomæus Eustachius* published at Venice a work called "*Opuscula Anatomicæ*," which is highly spoken of. He is distinguished for his Anatomical pursuits and discoveries.

The 17th century opens with the brilliant discovery of the circulation of the blood, by *Dr. Wm. Harvey,* in 1628.

The previous discoveries of Fabricius on the *valves* in the veins—and those of Servitus, Columbus and Cæsalpinus, on the circulation through the lungs, were very important links to Harvey in making his immortal discovery. He met with

much opposition at the time, but lived to see his doctrine universally embraced. In 1642, Wirtsungius discovered the *pancreatic duct.* *Aselius*, an Italian, discovered the *lacteals*, which *Pecquet* in 1651 traced to the thoracic duct, and on to the subclavian vein. In this same year *Thos. Bartholine* has the credit of discovering the lymphatic vessels—though a Swede by the name of *Olaus Rudbeck,* and *Jolivius* an Englishman, both put in their claims for priority of discovery.

In 1660, *Marcellus Malphigius* became eminent for the accuracy of his descriptions, and for his discoveries of new structures.

About this period, *Johannes Swammerdam* made some Anatomical publications, and was particularly celebrated for his manner of preserving different portions of bodies by injecting their vessels.

In 1665, *Frederic Ruysch*, the great Dutch Anatomist, made his first Anatomical publication, which he continued for a period of 65 years, being universally celebrated for his minute injections, and for preserving every part of the body in its natural color, and with all its original freshness and beauty.

In 1683, *Gothofridus Bidlow,* Professor of. Anatomy at Leyden, published his "*Anatomia corporis Humani,*" wherein it is said the several parts are represented in plates as large as life. The plates are supposed to be those of Swammerdam, which had never before been made public.

Shortly after this, *Diembroeck, Professor of Anatomy at Utrecht,* prepared a work which became the standard work among students.

Antonius Leuwenhoeck about this time also distinguished himself by the use of the microscope.

The names of Albinus, Winslow, and Cheselden, with many others, are all famous in this century for their anatomical knowledge.

The 18th century presents the brilliant names of *Bichat*, the father of *General Anatomy, Morgagni, Scarpa, Soemmering,* the *Monros*, the *Hunters*, and a host of others.

The 19th century is no less remarkable for its onward march and progressive improvement in Anatomy. Every nation seems to be vying with every other in that most honorable and useful of all species of rivalries, a more complete—yea, the most perfect knowledge of the structure of the body possible—with the view of more fully *preserving health* and *prolonging* life; and the kind of Anatomical discovery and improvement which characterizes the present period, may be designated by the term *Microscopic Anatomy.* In this department figure the names of *Schwann, Muller, Andral, Magendie, Carpenter, Nasmyth, Goodsir*—and in our own country, the names of *Wistar, Godman, Horner* and *Leidy,* may be mentioned—the two former being more particularly distinguished for their observations in the ordinary mode of dissections, while the latter have directed special attention to microscopic Anatomy. Numerous others equally eminent and indefatigable in our own and every other country, might be mentioned, who are now unceasingly engaged both in *microscopic,* and all other species of Anatomical *analysis* and research, which can by any possibility shed a more perfect light and thorough knowledge upon the wonderful minuteness, complexity, and harmony in the structure of the human frame.

Every portion of the body, whether solid or fluid, is being subjected to the magnifying power of the microscope, and the most interesting discoveries are being made in each. The various fluids, comprising the *blood, chyme, chyle,* and the different *secretions* and *excretions,* have all been subjected to this mode of examination, and the globules whose shape and appearance, with other characteristic properties of the fluids, were hitherto doubtful and disputed, are now settled with precision and accuracy.

The cell of Schwann, and epithelia, which are likewise found to be cells, are now known after this method, to exist upon all free membranes, *mucous* and *serous,* as well as *cuticular.*

All these details of modern discoveries are, however,

noticed in their appropriate places throughout the present work, so that it is unnecessary to make further remarks in this place, or pursue the history of Anatomy in any greater detail at present.

RULES FOR DISSECTION IN GENERAL.

1. Let each student supply himself with an apron, made either of glazed muslin or gum elastic, furnished with sleeves, and reaching from the neck to the ankles.

2. He should provide himself with a dissecting case, in which he should see that there are also two or more crooked needles, for sewing up the parts after dissection. He should also have a sponge, as cleanliness is of the utmost importance to neatness of dissection.

3. No more integument should be turned down than is necessary to fairly expose the part or parts under examination, as the dissection is liable soon to become dry or putrefy—hence it is always necessary to replace the skin, or cover the parts with a cloth of several thicknesses, dipped in water, after dissection.

4. The knife should not only be sharp, but be in the best order possible, and always be kept so; for we are convinced, from much observation, that most of the failures, to the making a neat and satisfactory dissection, arise from having dull knives, and the consequence is disappointment and ultimate dislike, if not disgust, for any dissection whatever—hence we would urge each student to furnish himself with a razor-strop and Arkansas stone.

5. Hold the knife as you would a writing pen, and with the other hand keep the skin tense. We say with the other hand, for the fingers are always to be preferred, when you can use them, to the forceps. The skin is made tense, or put on the stretch, so that the cellular tissue be-

neath it, and covering the muscle, shall likewise be put on the stretch—then, with a light and steady stroke of the knife, cut in the direction of the muscular fibres, and close to them, so as to be sure that all cellular tissue is removed, and the muscle thus fairly exposed. Indeed, if the student will simply recollect to keep his knives in first-rate order, hold the integument tense, and always cut in the course of and close to the fibres of the muscle, he cannot fail to make a neat dissection.

ORGANIZATION.

The structure and functions of the organs belonging to living beings constitute the science of organization.

The vegetable and animal creation compose its two great divisions.

It is the animal organization which claims our attention.

An *organ* is regarded to be any portion of a living body capable of performing a complete act or operation, and this act of the organ is styled its *function*—thus the eye is the organ of sight—the ear, the organ of sound and hearing, &c.

A number of organs, of different kinds, conspiring to one end, or to bring about one result, constitute an *apparatus*, as the apparatus of digestion, the lachrymal apparatus, &c.

Organs of the same kind form a *system*, as the muscular, osseous and nervous systems—and

The organs collectively have been styled the *organism*.

A variety of definitions have been given as to the essential nature of organization. One physiologist defines it to be the "process by which an organized being is formed, and organism the *result* of such process."

By another, organization is made to consist in a "peculiar form and structure, containing liquids of the same nature as itself."

By others organization is considered as the result of life; while some again view life as the result of organization, each alternately being made cause and effect.

The celebrated Bichat describes life to be "the sum of the functions by which death is resisted."

Another physiologist makes life to consist in "the phenomena peculiar to organized bodies, taken as a whole."

M. Beclard asserts that life consists essentially in one fact, "that all organized bodies, during a determined period, are *centres* penetrated by foreign substances, which they appropriate to themselves, and from which issue others that become foreign to them; and in this movement of momentary formation the matter of the body changes continually, but its form still remains." He adds, that life does not consist in a re-union of molecules, which were before separated, as occurs in the case of chemical attraction, nor simply in an expulsion of the elements previously combined, as in that which is produced by the expulsive action of caloric, but in a movement of temporary formation, in which some elements remain united, which would separate should life cease, and in which the elementary parts are separated without the action of caloric, and this vital action exists only in organized bodies; and it is in this "close and reciprocal connection of organization and life that is to be found the reason why they have by turns been considered the cause and effect of each other."

M. Beclard very justly remarks that organization and life are a complex idea—are inseparable in their connection, and that life is "organization in action."

Without entering into the abstract question of what is life?—a very unprofitable and, we think, useless speculation—we will at once proceed to consider the *fundamental elements* of organization, whose analysis is its only correct definition.

The first element we notice as fundamental and essential to organization, is that the organized body shall have a *definite living origin;* that it shall be born of a parent like

itself—grow, attain maturity, decay and die, after the manner of the being it represents.

Inorganic bodies, or those destitute of life, on the contrary, are not born, but simply owe their origin to what are termed the "general forces of matter." They do not grow, but owe their increase to accident, which occurs whenever particles, for which there is an affinity, come within the sphere of their attraction.

Neither do they attain maturity, decay, or die, as they are destitute both of a living birth and growth.

The second fundamental element of organization is a *special and definite form.*

This we see every where throughout the vegetable and animal kingdoms. Every plant and flower—every tree and fruit—every animal—every genus and species, each after its own kind, has this special and determinate *form,* by which it is readily distinguished from every other form.

Inorganic bodies, on the other hand, have no fixed and determinate form.

The third element is a *definite size.*

This is equally true, as of the form, in all the individual genera and species, both vegetable and animal.

We see them all to have a special and determinate *size,* and though there may be occasional dwarfs, these are but exceptions, which, instead of overthrowing, rather confirm the general law.

Inorganic bodies, it is well known, have no fixed size, but may be large or small, and constantly changing, just as accident makes them.

The fourth element essential to organization is a *definite* and *peculiar structure,* or a regular and determinate arrangement of fibres, forming cells or areolæ, and constituting the cellular, areolar or spongy tissue.

This peculiar structure, which does not belong to the inorganic body, constitutes the principal basis of all organization; it is viewed as the primitive, original and

forming part, entering into the whole organization, and constituting its most extensive and universal elementary solid.

The fifth element is the *nutritive fluid.*

This, called the sap in the vegetable, is the white or red blood in the animal.

The relative proportion of this fluid varies in the two kingdoms; it is greater in the animal than in the vegetable, and greater in youth than in old age.

The sixth element is *nutrition.*

This belongs to the whole organic world—from the blade of grass to the towering oak—or from the simple worm to the huge elephant—the forms of nutrition infinitely varying, but the result the same in all, to wit, the appropriation of material for organization and its preservation.

It is upon this universal function that the growth of all organic bodies depends—the material of supply being from within the body.

Now nothing like nutrition is seen in the inorganic being, for when it grows it is not from within itself, and by a complicated process of action as occurs in the organic body, but simply by the addition of particle to particle of similar nature from without, and upon its superficies.

A seventh element is the complete *dependency* of all the parts composing every organic body, and this is most especially true of those which are high in the scale of animal formation.

For here it is certain death to any part to be separated from the body of which it forms a portion, while the body itself suffers, in turn, in proportion to the importance of the part it has lost, and if it be any of the essential organs of life, death is as instant to the whole body as to these parts.

It is true some animals, very low in the scale, as the polypus, may be separated into pieces, and each piece not only has the power to live, but still further to recreate itself into a perfect animal.

In this case each fragment seems to possess all the parts of the whole animal, each having the generative and nutritive power perfect; there then seems to be no necessity that any of these parts should die.

But let a section be made in what is called the eye or germ of these animals, and death is as certain as in the higher order; for here the chain of dependency among the several parts, making each fragment, as it were, complete in itself, is broken, and this essential element to organic existence as certainly destroyed.

In the inorganic body we observe no such dependency among its several parts. Each can preserve its existence as well when separated from all the other parts and from the whole body as when united.

The eighth element of organization is a *limited duration.*

Death is the eternal fiat stamped upon all living, organic bodies—they carry on their functions for a definite period of existence only, during the active and early exercise of which, the body grows, attains maturity, and then begins to languish, decay and die.

Inorganic bodies, on the other hand, have no fixed period of duration—their existence can be terminated at any moment, either by mechanical violence breaking down their several parts, or by the play of chemical affinity destroying their nature, or if none of these circumstances operate, their duration may be unlimited.

These are the different elements which are regarded as the most essential in forming organization.

We now proceed to notice the principal of those most essential in *preserving* organization—which consist of,

1. Atmospheric air.	3. Water.
2. Food.	4. Heat.

These elements are the *vital stimuli,* whose presence is indispensable to the existence of all kinds of organization, whether animal or vegetable.

In the higher order of animals, the necessity of breath-

ing, taking food and drink, and having a proper temperature, is plainly manifest.

Though there are some, it is true, which have the power of apparently suspending their functions for a while and entering into a torpid state—and consequently, remaining in a great measure without the influence of the vital stimuli; they nevertheless exist, and again revive in their former activity.

This, however, by no means subverts the general law of the necessity of the presence of the vital stimuli to organic existence—for atmospheric air and a certain amount of temperature is present in sufficient quantity to account for the remaining vitality which is found to have been present, and again to revive on the re-application of the balance of the vital stimuli.

Now, between these two series of elements—the one for forming and the other for preserving organization, nature has established the most intimate relations—relations close, fixed and determinate—constituting so many laws which are essential to be obeyed for preserving the integrity of organization.

These relations or laws consist essentially in the nice adaptation of the one class of these elements to the other, when in their natural state of integrity.

Examples of violation of these relations are seen when carbonic acid gas, sulphuretted hydrogen, or any other noxious gas is taken for atmospheric air, or when putrid food and alcohol are taken in the place of bread and water.

The result of these violations, in destroying organization, health and life, is familiar to all, and therefore it is unnecessary to enter into any detail.

VARIETIES OF ANIMAL ORGANIZATION.

Nature it seems has constructed the animal kingdom upon four great models or types.

1. The Radiata—forming the zoophytes.
2. The Articulata—worms, insects, &c.
3. The Mollusca—shell-fish, &c.
4. The Vertebrata—having a spine.

The Radiata, so called from their resemblance to a radiated flower or star, are of simple structure, and described as having no distinct nervous system, no organs of sense, no heart, and having white blood.

This class includes the polypus, hydratid, coral, sponge, star-fish, infusoria, &c.

The *Articulata* are a step higher in organization, for here are found nervous ganglia, forming a longitudinal chain along the median line of the body. The body itself is divided into rings, which feature gives the name to the Class, and has a protection or kind of skeleton exteriorly of hardened skin, or horny covering, as seen in the insect and lobster. The blood is also generally white, and there is no heart, but simply a vessel running along the back called the *dorsal vessel*. There are senses, but they are more or less incomplete.

This Class includes the Crustacea, as the Crab, &c., the Arachnides or Spiders, the Annelides or Worms, and Insects.

The *Mollusca*, as their name implies, have the body soft, and like the Articulata, have nervous ganglia; but, instead of being united, these are found scattered throughout the body, and not in a chain along the middle line. The senses are also incomplete, the blood, white; but here we find a heart.

There are no rings, no external skeleton, but simply a stony crust or covering constituting the shell.

The Snail, Oyster, Nautilus, &c., are specimens of this Class.

The *Vertebrata* form the next and highest step in the animal kingdom.

This Class, deriving its name from all its members having vertebræ or a spine, is principally characterized by the body being symmetrical, the nervous system being composed of a brain and spinal marrow, as well as nervous ganglia, by the blood being red and warm, and there being a heart and five senses.

These four divisions, constituting the four great varieties of animal organization, have each many subdivisions into the different orders, genera and species.

Each of these varieties, with its various subdivisions, as already stated in reference to organization in general, owes its existence and preservation entirely to the fixed relation established between its peculiar structure and one or more of the fundamental elements of preservation.

We shall take the division of the vertebrata by way of illustration.

The vertebrated Class has four principal branches—Fishes, Reptiles, Birds, and Mammalia.

Now the organization of Fishes is constructed with special reference to the element, water—the whole exterior and interior form, as the fins, gills, air-bladder, &c., all clearly show that water is their natural element—and that notwithstanding they require air and food, and have more or less relation with these principles, yet the great and prominent relation is with water, without which the whole variety would soon cease to live, though there might be free supply of both air and food.

Reptiles have a modification of structure which adapts them to both water and air, in each of which some of them alternately live, as in the cases of the turtle, crocodile, frog, &c.

Birds being made for flight, have their special relations with the atmosphere. This is their essential and peculiar

element, as their whole organization shows. For we find the exterior of the body covered with feathers—the remarkable property of which is lightness—nicely adapted for sustaining them in the air. The lungs occupy the abdominal as well as thoracic cavity, there being no diaphragm, and thus, extending the almost entire length of the trunk, form as it were so many bladders, which being filled with air, give the body the same specific gravity with this fluid—consequently placing the animal in the most perfect relation for moving and living in this element. The skeleton likewise receives air, thus rendering the body still lighter—and so with every other part, each being adapted the one to the other, and the whole specially to the atmosphere, the fundamental element of this variety of organization—for a bird can no more live under water, than a fish can in the air.

The class *mammalia*, divided into the carnivorous and herbivorous animals, have organizations formed with special reference to food—the one of these living on flesh—the other on grass, fruits and grain, and the structure in each, as most distinctly seen in that of the teeth, stomach and alimentary tubes, corresponds to the particular kind of food on which they respectively subsist—and so fixed is this relation between the kind of food and the organization adapted to it, that to change the food of the one class for that of the other, would be death to both.

The same may be said in reference to climate. The polar bear could no more live under the equator, than the ourang-outang could under the north pole—each having its organization made with special reference to temperature.

Now, in all these instances we find the variety of organization depends upon fixed relations—established more particularly with one of the fundamental elements than another—which particular relationship constitutes so many special laws for each variety—violation of which in each case is destructive to organization, and that just in proportion to the offence. But these special laws by no means

conflict with or exempt from the operation of the general laws to which all organization is subject.

The last example of variety we have to offer, is the *organization* of *man.*

Man, it is well known, stands at the top of the animal scale—forms the highest and most perfect link—is the most complex and varied—has the most extensive and multiplied relations, and the greatest number of properties and powers. And as organization differs and becomes complex in proportion to the number and variety of its properties and relations, we find in man's formation a miniature representation of all we see in the inferior animal world—with the addition of his own distinguishing and surpassing structure, adapted to his *intellectual and moral powers.*

CONSTITUENTS OF HUMAN ORGANIZATION.

Analysis resolves the constituents of human organization into,

1. Chemical.
2. Organic elements.

The chemical consist of oxygen, hydrogen, carbon, nitrogen, sulphur, phosphorus, chlorine, fluorine, potassium, aluminum, calcium, sodium, magnesium, silicium, iron, manganese, to which some have added titanium, lead, copper, iodine and bromine.

Of these, nitrogen and oxygen are found in a simple, pure state—both in the blood, and nitrogen in the intestinal gases.

The rest exist as binary, ternary, or quartenary compounds. The binary are inorganic compounds, and consist of,

1. Water, composing the largest portion of the fluids of the body, entering into the solids and producing the different degrees of softness.

2. Carbonic acid, found in the blood, exhaled from the lungs, skin, urine—as well as united with lime, potash,

soda, forming the *carbonate of lime* in the teeth, bones, cartilage, &c.

Carbonate of potassa in the serum.

Carbonate of soda in the serum, bile, saliva, tears, sweat, mucus, teeth, bone, cartilage, &c.

There are also carbonates of ammonia in the urine, and of magnesia in the grease of the skin.

3. The union of phosphoric acid with lime, soda, ammonia, &c., as, for example, the phosphate of lime composing by far the greater bulk of the bones, and also existing in the teeth, cartilages, and pineal gland.

The phosphates of soda and ammonia are seen in the urine, the blood, saliva, tears, &c.

4. The compounds of Chlorine, as those with hydrogen sodium, potassium, ammonium, and calcium, forming chlorides of these bodies, are seen in the gastric juice, blood, brain, muscle, bone, cartilage, dentine, pigment, milk, saliva, sweat, &c.

5. Sulphates of potash, soda and lime, are seen in the cartilage, gastric juice, urine, bile, sweat, hair, cuticle, saliva. And other binary compounds are also discovered to exist, as the fluoride of calcium and alumina, in enamel of the teeth, silica and oxide of manganese in the hair, oxide of iron, in hematine and black pigment, oxide of titanium, and sulpho-cyanide of potassium in the saliva.

The ternary and quarternary compounds include the *Organic Elements*, whose distinguishing feature is, that they are only found in living bodies, whether animal or vegetable, and that the most prominent of them possess an additional element, not found in the inorganic, which is nitrogen, upon whose presence depends the rapidity with which some structures become putrid, or pass into decomposition. This remark refers more particularly to the animal compounds—the vegetable products, with very few exceptions, are deficient in nitrogen. The *Organic Elements* having nitrogen are,

1. Protein,	6. Globulin,
2. Albumen,	7. Spermatin,
3. Fibrin,	8. Mucus,
4. Casein,	9. Lachrymal matter,
5. Pepsin,	10. Keratin.

Protein is regarded as the basis of all the other elements, is found in every animal, and it is said that no tissue or organ is destitute of its presence.

It can be obtained by boiling albumen in a weak solution of caustic potass, and then precipitating with an acid.

The gluten of wheat-flour, after the starch is washed away, and treated in the same manner, also yields protein.

Thus obtained, in the moist state it is gelatinous, without smell or taste, insoluble in water, ether or alcohol, but soluble in dilute acid. When dry, it is hard, brown, and brittle.

According to *Mulder*, its discoverer, it is chemically composed in atomic weights, of carbon 40, hydrogen 31, nitrogen 5, oxygen 12.

Albumen is found in the serum of the blood, lymph, chyle, and a beautiful specimen is seen in the white of the egg. It is one of the special elements of the brain, and exists also in pus, and many of the secretions.

It is yellow and brittle when dry, coagulates by heat, creosote, spirits of wine, and some acids; is soluble in water, and forms an insoluble compound with corrosive sublimate, sugar of lead, alum, nitric and tannic acids.

It is composed, according to Gay Lussac and Thenard, of

Nitrogen,	15.705,
Carbon,	52.883,
Hydrogen,	7.540,
Oxygen,	23.872, in an hundred parts.

Fibrine constitutes the basis of the muscular system, exists in the blood, chyle, lymph, and in abundance upon

inflamed surfaces, is soluble in the blood, from which when drawn it readily coagulates.

It can be obtained from the blood, by stirring it briskly with a rough stick, when it will appear in the form of fibres or threads. Vegetable acids, their salts, and caustic alkalies prevent coagulation.

Its chemical elements are

Nitrogen,	19.934,
Carbon,	53.360,
Hydrogen,	7.021,
Oxygen,	19.685, in the hundred parts.

Casein exists most abundantly in milk, but is also found in the blood, saliva, bile, pancreatic fluid, lens, and elsewhere. In solution it is of a pale yellow, coagulates by heat, acids, alcohol, and rennet.

It is soluble in water, and in this state has the consistence of mucilage.

When dried it is of an amber color, and very friable.

Cheese is composed of dried casein and butter. According to Mulder its chemical elements are in one hundred parts—

Nitrogen,	15.95,	Hydrogen,	6.97,
Carbon,	55.10,	Oxygen,	21.62.

These four organic elements constitute the great proximate principles of animal formation.

And the albumen, fibrin, and casein, seem to be formed from the protein, or more properly speaking, only differ from it by having in addition a little sulphur and phosphorus in combination.

Protein, it has been stated, is always found in the albuminous vegetables, and has the same constitution in them as in the animal frame. Hence, we can readily understand how and why it is, that vegetable matter is so readily converted into animal, and so important in sustaining life.

The other elements not so extensively diffused, we will briefly notice. They are as follows:

Pepsin was discovered by Schwann in the gastric juice, the parietes of the follicles and glands of the stomach, and may be obtained by macerating the stomach of an animal. With an acid it readily dissolves albumen and fibrin—resembles very much albumen—and is considered the active agent in digestion, the prime element in converting the food into chyme.

Chemical Analysis makes *Pepsin* consist of Oxygen 10, Hydrogen 32, Nitrogen 8, Carbon 48.

Globulin exists in the envelopes of the blood corpuscles, and resembles albumen. Simon regards it as casein united with hæmatin.

Spermatin is found in the seminal fluid, and looked upon as probably only fibrin.

Mucus is furnished by the mucous glands. It is insoluble in water, transparent when evaporated to dryness, is soluble in acids, does not coagulate by heat, is precipitated by tannin, and is always found united with the cast-off epithelium and pus.

Lachrymal matter. This is found in the tears after evaporation, and is regarded as insoluble mucus.

Keratin is so named from being found in the nails, hair, and cuticle, though its character is not yet fully determined.

EXTRACTIVE ELEMENTS.

When protein and the salts are removed from animal matter, what is left is called *Extractive matter.*

This is found pretty generally diffused through the body, but most abundant in muscle.

The dried extract of flesh, if treated with water, diluted alcohol, or pure alcohol, forms either a water extract, spirit extract, or alcoholic extract.

The spirit extract is termed ozmasome, (from οσμη, smell, and ζωμος, soup,) because it gives the flavor to soups.

Ptyalin or *Salivin*, is a substance found in saliva, and *Kreatin* in the fluids of meat.

Gelatin—colla or glue—abounds in the cellular tissue, bones, cartilages, tendons and ligaments.

It is obtained by boiling, by which means it is soluble, and on cooling becomes a jelly.

Its chemical elements, according to *Mulder*, are in one hundred parts, Nitrogen 18.350, Carbon 50.548, Hydrogen 6.477, Oxygen 25.125.

Chondrin forms the basis of the cartilages; it resembles gelatin, and exists in the cartilages of the ear, nose, ribs, &c.

Its chemical composition is made to consist of Nitrogen 14.44, Carbon 49.56, Hydrogen 6.63, Oxygen 28.59, Sulphur 0.38.

Both Chondrin and Gelatin also contain phosphate of lime.

Hæmatin forms the coloring matter of the blood, and is found in the envelopes of the colored globules. It contains iron, and is soluble in alkalies. When dry it is dark brown, and without taste or smell.

Pyin, as its name implies, is found in pus, and resembles gelatin.

Bile.—The essential principle of bile, according to Berzelius, is bilin, which, when dry and in a pure state, is without color, transparent, very soluble in water, bitter in taste, not crystallizable, and decomposable by acids. It forms, with acids and bases, soluble compounds, and shows neither acid nor alkaline reaction.

It is regarded as resinous, and contains a biliary sugar.

Urea is found chiefly in the urine. It is also discovered in the blood and its secretions, when there is disease of the kidneys. It is obtained by adding nitric acid to the urine after its evaporation to the consistence of sirup, when there is produced the nitrate of urea. The nitric acid is removed by the carbonate of barytes, and the urea dissolved in alcohol, which latter is driven off by evaporation.

Urea is described as colorless, and presenting four-sided prisms, or long, "silky, shining needles." It is without smell and has neither acid nor alkaline reaction.

Uric acid is found mostly in the urine of carnivorous animals or those which feed on flesh, and is also seen in urinary calculi, and gouty concretions. The excrements of birds consist almost entirely of this acid, united with ammonia, constituting the guano of commerce. It is precipitated at a low temperature, and the precipitate is at first grey, then a pale rose color—on drying it assumes the form of scales—this acid readily dissolves urea.

Animal matters which are destitute of *nitrogen*. These consist,

1. Sugar of milk.
2. Lactic acid.
3. Fats.

Sugar of milk, according to chemistry, composes two-fifths of the solid constituents of human milk. It is obtained from the whey by evaporation and crystallization, after removing the casein and fat.

It is easily soluble in water—harder than cane-sugar, and slightly sweet. Its specific gravity is 1. 543. Its crystals form four-sided prisms.

Liebig makes its elements consist of carbon, 12 atoms, hydrogen 24, oxygen 2.

Lactic acid is found in all the fluids and secretions of the body. It exists in a free state in the milk, sweat, urine, and muscles, and in combination with lime, potash, soda and magnesia—holds phospate of lime in solution, and is supposed to predominate when this element is deficient in the bones. It is a strong acid, without smell or color, coagulates albumen and casein, and is decomposed by heat. Its salts are soluble in water, and crystallizable.

Fats are found free in the cellular tissue and medulla of bones, or in combination with other substances, as in the milk, brain, hair, wax of the ear, pus, &c.

They are insoluble in water—but soluble in hot alcohol and ether, forming compounds of carburetted hydrogen, with some oxygen.

Some of them by combining with an alkali, form soap—and with the oxyds of lead, plasters.

This is effected by the acids they contain uniting with the base and forming salts.

Of the saponifiable fats, there are three substances recognized as forming a base.

1. Glycerin. 2. Oxyd of Cetyl. 3. Cerin.

The first is the base of human fat, and is extensively diffused among animals—the second belongs to spermaceti and the third to wax.

Glycerin is obtained by boiling fat with oxyd of lead. It is said to be sweet, yellow, without odor, soluble in water, but not soluble in ether.

The acids combining with this base are the stearic, margaric and oleic—forming stearin, margarin and olein, substances known familiarly as suet, lard and oil.

The union of these two classes of elements in varied proportions, constitutes the solids and fluids of the body.

DEVELOPMENT OF ORGANIZATION.

Organization, consisting as it does of a variety of parts, we will briefly remark, advances by a series of steps—not simultaneously, but in a regular and definite succession, at regular and definite periods—after a regular and established form—and in obedience to established fundamental laws.

Special development will be noticed in the examination of individual organs.

Table of differences between dead inorganic, and *living* organized bodies, as given by M. Magendie.

These differences consist in the *form*, *composition* and *laws* which govern them.

FORM.

Inorganic bodies.	Form angular. Volume indeterminate.
Living bodies.	Form rounded. Volume determinate.

COMPOSITION.

INORGANIC BODIES.	LIVING BODIES.
Sometimes simple.	Never simple.
Rarely formed of more than three elements.	Having at least four elements, often eight or ten.
Constant.	Variable.
Each part can exist independent of the rest.	Each part more or less dependent on the rest.
Capable of being decomposed and restored.	Capable of being decomposed, but not of being restored.

LAWS WHICH GOVERN THEM.

INORGANIC BODIES.	LIVING BODIES.
Entirely submissive to the laws of attraction and chemical affinity.	Partly submissive to attraction and chemical affinity. Partly governed by an unknown power.

ANATOMY, (ανατεμνειν, to dissect.)

Divisions.—The world of life being divided into two great departments, *vegetable* and *animal*, the beings of each, when examined by dissection, cause the division of Anatomy into

1. Vegetable Anatomy, or Phytotomy.
2. Animal Anatomy or Zootomy.

Animal Anatomy is divided into

1. Human Anatomy.
2. Comparative Anatomy.

The former treats of the organs of the human body—the latter of those of the inferior animals.

Human Anatomy is divided into

1. General Anatomy, which takes up the same tissue, and follows it throughout the system, into every organ, and examines it in all its relations and properties, physical, organic, and vital. The celebrated Bichat is the founder of General Anatomy.

2. Special Anatomy, which takes up each organ, one by one, and minutely examines all the different tissues of which it is composed at the same time, showing the situation of each organ, its form, size, interior structure and relations.

The difference between these two kinds of Anatomy is thus explained by Bichat:

Chemistry, says he, has its simple bodies, as heat, light, oxygen, hydrogen, carbon, &c., whose various combinations form all the bodies we see on the face of the earth. So Anatomy has its simple tissues, by whose varied combinations all the different organs of animals, as well as the human body, are formed.

There are other divisions of Anatomy, as

Surgical Anatomy, which treats of those portions of the body having special reference to the treatment of Surgical diseases.

Regional or *Topographical Anatomy*, when all the organs in any particular region or section, are examined collectively; and

Pathological Anatomy, when the organs are examined in a state of disease.

PART FIRST.

THE ALPHABET OF ANATOMY,

OR

ELEMENTARY TISSUES OF THE BODY.

PART FIRST.

CHAPTER I.

ORIGIN OF THE TISSUES.

TISSUE is a phrase applied to an elementary part, or structure of the body, and consists in a peculiar arrangement of fibres.

An Organ is composed of several Tissues.

FIG. 1.

The *Nucleated Cell,* (fig. 1,) from observations with the microscope, first announced by Schwann in 1838, is now generally received as the elementary, or first form, in which animal matter is developed, and from which, as the basis, all organic structures, whether vegetable or animal, are formed. This cell is described as a vesicle of delicate membrane, containing a fluid, and a minute dark nucleus, called Cytoblast, or Cell-germ (from κυτος, cell, and βλαστος, germ,) and is surrounded by an amorphous substance, either solid or fluid, called blastema or cytoblastema, from which the cell itself springs.

The Nucleus presents a round or oval shape, somewhat flattened, its surface smooth or granular, of a yellowish red, or without color, and having a diameter from the four-thousandth to the two-thousandth part of a line.

FIG. 1. Represents the Cell with its contained Nucleus, and the Nucleus without any Cell.

It arises, as is supposed, by the blending together of the granules about a central point, as they are being deposited from the amorphous mass—their common birth-place and origin.

This mode of origin and development has been observed in the egg of animals and germ of plants.

The *Nucleated Cell*, thus formed, multiplies in number, and blends and coalesces with the newly formed cells, and by various metamorphoses ultimately forms all the different tissues of which the body is composed.

The cells increase, either by the origin of new ones, singly—and independently the one of the other—or by the primary cell developing within itself a series of new secondary Cells, which, in their turn, give origin to others, and so on, successively.

The Hair, Nails, and inflammatory exudation, are cited as examples of the first mode of increase—and the Liver, and pathological growths, as scirrhus, as specimens of the second.

The Cells, as they are passing through their various stages of development, to the formation of the different tissues, necessarily change their shape, position, contents, and relations; as, for instance, in some Tissues they preserve their independence, and, by being situated the one upon the other, become thereby flattened, or pointed and elongated: others increase in size, as the fat Cells, or diminish in size, as the lymph corpuscles when changed into blood corpuscles; or lose their Nucleus, as in the mature blood-corpuscle; or have their parietes thickened, as the Cartilage Cells.

The Cells, in most of the Tissues, come together and coalesce. By this process the cavities of the Cells present two conditions; in the one case they remain open, in the other they disappear.

Examples of the remaining Cell cavity are seen in true Cartilage and Osseous Tissue, where the thickened cell walls are blended together, or their parietes, in contact with one

another, give way and form continuous tubes, as those of the renal and seminal tubuli.

In the second case, where the *Cell cavity* disappears, the parietes of the Cells lie flat together, forming solid laminæ, as in membrane.

The Nuclei of the Cells elongate and coalesce, and form nucleus fibres, which differ from the Cell fibres by being insoluble in acetic acid.

PHYSICAL PROPERTIES OF THE TISSUES.

The different Tissues possess the properties of density, color and consistency, as matter in general: some of them also have elasticity and pliability, properties which are due to the presence of water.

VITAL PROPERTIES OF THE TISSUES.

The vital properties are termed Contractility, Sensibility, and what is called the Formative force. *Contractility* manifests itself in the shortening of living tissues under the influence of mechanical or chemical stimuli, or the stimulus from the nerves, as seen in the muscles. Voluntary contractility belongs to the muscles of locomotion, which contract through the agency of the brain. There is another kind of contraction, permanent in its character, arising from a great degree of heat, and is a sort of crisping not to be confounded with vital contraction.

Sensibility of the tissues is due to the nerves and their connection with the brain, and the amount of sensibility which any tissue may possess is measured by the number of its sentient nerve fibres.

The Formative force, called also the *Plastic* or *Assimilative force,* is that power in the different tissues to form themselves out of materials altogether unlike those of which they are severally composed; and formation, assimilation, and nutritious processes are terms applied to the working of this power.

THE NUMBER OF TISSUES.

1. The Blood.
2. Cellular Tissue, comprising
   a. Adipose,
   b. Serous,
   c. Synovial,
   d. Bursæ Mucosæ.
3. Vascular—
   a. Arterial,
   b. Venous,
   c. Lymphatic.
4. Nervous—
   a. Animal,
   b. Organic Life.
5. Glandular.
6. Cutaneous—
   a. External or Skin,
   b. Internal or Mucous membrane.
7. Muscular—
   a. Animal,
   b. Organic.
8. Fibrous—
   a. Ligament,
   b. Aponeurosis.
9. Cartilaginous.
10. Fibro-cartilaginous.
11. Erectile.
12. Osseous.

Anatomists differ as to the number of Tissues—Bichat makes 21, Horner 18, Dupuytran and Richerand 11.

CHAPTER II.

THE BLOOD.*

The Blood being the fountain for the growth and sustentation of the whole body—the source of supply for the development and preservation of every part—and the ways and means for supplying all the waste places of the economy,

* M. Magendie, in his work on the Blood, says all its constituents have "special functions"—a prominent character of the Tissues—and so far may claim consideration in common with the Tissues. But an additional reason for placing it among the Tissues, is first, that it is the source of all the Tissues, furnishing the materials for all the organs, and is also the matrix for the mature cell, and being thus fundamental to the whole, seems naturally to demand examination first.

has in the first place vast importance, and in the second a fundamental position in relation to all other parts.

With this view of the subject, we have been in the habit, and have found it a most profitable one to commence our investigations in Anatomy, by first making a brief examination of this fluid as containing the primitive and formative element of the whole body.

All the prominent and most important facts in relation to the blood, of which we only propose to give as concise a statement as possible, may be arranged under four heads:

1st. The physical properties and relations of the blood.
2d. Its chemical properties and relations.
3d. Its microscopic properties and relations.
4th. Its vital properties and relations.

When blood is drawn, we find it naturally separating into two parts—the one thick, called the crassamentum or clot—the other thin and fluid, the serum.

The proportion which these bear to each other, is stated to be four-fifths of clot, to one-fifth of serum.

The crassamentum is the portion which forms the firm solid mass by coagulation, and is colored, from containing the red globules.

The serum is the yellowish, transparent, watery part in which the clot is seen to float.

The blood, while circulating in the body, consists also of two portions—a solid and fluid—the solid being the globules, while the fluid is called the liquor sanguinis, which holds both crassamentum and serum in solution.

The *Liquor sanguinis*, or *plasma*, is described as a pale and clear fluid, containing the corpuscles, and when drawn, presents as its striking characteristic, a disposition to coagulate.

During coagulation, the corpuscles are retained, but can be separated by the filter, as recommended by Muller.

In inflammatory diseases the red corpuscles subside before coagulation occurs, leaving the upper portion of the blood

a clear liquid. The liquor sanguinis has, however, the pale corpuscles mixed with it, which are found to collect at the top, and this clear liquid which is found at the top after coagulation, when inflammation has been present, is styled the *buffy coat*, and is found to separate into fibrin and serum.

The liquor sanguinis shows under the microscope numerous fine filaments variously interwoven.

The fibrin may be separated from the blood by stirring it with a stick roughly notched, and its proportion is supposed not to exceed two and one-half parts in the thousand. Its quantity is regarded as greater in arterial than venous blood.

The *color* of the blood is the first physical property we notice. This is a beautiful red or vermilion in the arteries, modena or purple in the veins, and still darker in the vena portæ.

Its *quantity* has been variously estimated by different physiologists—the extremes being 8 pounds for the lowest and 100 pounds for the highest.

The calculations of Hoffman and Valentin are regarded as coming nearest the truth. Hoffman makes the weight of the blood to the whole body as 1 to 5—hence, an individual weighing 150 pounds, has 30 pounds of blood or nearly 4 gallons.

Its *smell* is faint and peculiar, and has been compared to a fragrant garlic odor.

The *taste* is slightly saline and peculiar.

To the *touch* it is viscid. It is also coagulable, has a temperature of about 98° or 100° Fahrenheit, and a specific gravity, when compared with water, of 1.0527 to 1.0800.

In reference to the property of coagulation in the blood, M. Magendie remarks that it is a "fundamental point in the theory of the blood, that in order to support life it must be coagulable," and that where it loses this property, life must cease and death is inevitable; and this is what is believed to occur in all those destructive epidemics, as the cholera, plague, and yellow fever, the blood in each being in a fluid state and not capable of coagulation.

A variety of agents are found to destroy this property in

the blood. The lancet in frequent bleedings, putrid water, the poison of the viper, fumes of charcoal, bicarb. sodæ, nitre, digitalis, with many others, have this agency.

But there are fortunately other agents which have a tendency to promote coagulation, and to arrest the disposition to its destruction. Among these stands at the head of the list water, then sulphate of magnesia, nitrate of silver, &c.

This property of the blood being of such great importance in the preservation of health and life, we deem it not out of place here to give a brief summary, from the experiments of M. Magendie, of all those agents which he found to aid or promote this principle of coagulation, and all those which destroyed it.

Under the first head of agents promoting coagulation, are arranged:

Water,	Seltzer Water,
Sugared Water,	Vichy Water,
Hydrochlorate Sodæ,	Seidlitz Water,
" Potassæ,	Ioduret of Potass,
" Ammonia,	Tart. Ant. and Potass,
" Baryta,	Sulphat. Magnesia,
Serum of Ascites,	Alcohol,
Boracic Acid,	Cyanuret of Gold,
Borax,	" Mercury,
Nitrate of Silver,	Hydrochlorate and Mannite of Morphia.
Hydrosulphates of Potassa and Ammonia	

Second class, or agents which destroy coagulation.

Sulphuric,	Acids.	Potassa,	
Hydrochloric,	Acids.	Lime,	
Nitric,	Acids.	Ammonia,	
Tartaric,	Acids.	Sodæ,	Carbonates.
Oxalic,	Acids.	Potassæ,	Carbonates.
Citric,	Acids.	Ammoniæ,	Carbonates.
Acetic,	Acids.	Potassæ,	Nitrates.
Tannic,	Acids.	Lime,	Nitrates.
Hydrocyanic,	Acids.	Strychniæ,	Nitrates.
Lactic,	Acids.	Sulphate Morphia,	
Soda,		Nicotine.	

The gases and wines also modify this property.

Viscidity is another property of the blood equally important with its coagulation; for the same authority asserts that the circulation is due to this property, and if lost or taken away, the blood is arrested in its course.

He states the remarkable fact that if we attempt to introduce water into a tube of extremely small diameter, it will not enter, no matter what force be employed; but simply add a certain quantity of gum, gelatine or any mucilaginous substance, and the attempt becomes "immediately successful."

The blood, however, on the other hand, can be too viscid, and by adhering to the sides of the vessels mechanically obstruct the circulation.

The *force* with which the blood presses against the arteries, by the experiments of M. Poiseuille, is nearly the same in every part of the body.

The *rapidity* of the blood is estimated at 149.2 feet per minute; going the whole round of the circulation in about three minutes; requiring in this time about 240 beats of the heart, each beat sending forward 2 oz. of blood, and in one hour 20 times the whole weight of blood in the body.

There are other physical properties of the blood, as elasticity, density, cohesion, &c., all of which modify its character, and through it, to a greater or less extent, the different organs.

Now all the properties just enumerated owe their existence and value to the unalterable relations which nature has established between the blood on the one hand, and the external bodies of food, atmospheric air, water and temperature on the other—which relations, if we violate, will be vindicated by a proportionate alteration or destruction of the physical properties of the blood, and a consequent proportionate impairment of the health of the body.

The *chemical properties* of the blood are thus given by M. Lecanu, whose analysis is regarded as among the most accurate. He makes 25 distinct substances, to wit:

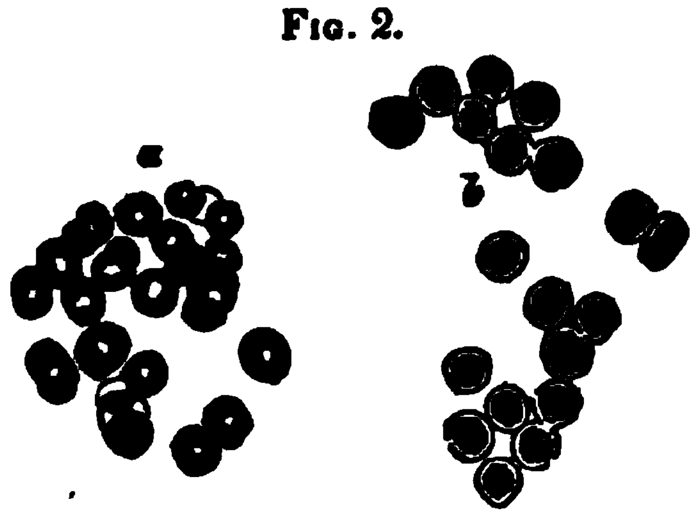
Free Oxygen,	Nitrogen,	Carbonic Acid,	
Extractive,	Phosphuretted Fat,	Cholesterin,	
Seroline,	Free Oxalic Acid,		
Margaric Acid,	Carbonate Sodæ,	Albumen,	
Hydrochlor. Potass,	Carbonate Lime,	Water,	
Hydrochlor. Sodæ,	Carbonate Magnes.	Fibrin,	Clot.
Hydrochlor. Am'a,	Lactate Sodæ,	Hæmatosin,	
Sulphate Potass,	Fatty Acid Salt,	Globules,	
Yellow Col. Matter.			

Of these substances the *serum* contains the water, albumen and salts, the analysis of which by the same chemist is in 1000 parts: Water, 906; Albumen, 78; Animal Matter, soluble in Water and Alcohol, 1.69; Albumen, combined with Soda, 2.10; Crystallizable Fatty Matter, 1.20; Oily Matter, 1; Hydrochlorate Soda and Potassa, 6; Sub. Carb., Phosphat. Sodæ and Sulphat. Potassæ, 2.10; Phosphate of Lime, Magnesia, 2; Iron, Sub. Carb. Lime, 2; Magnesia, 0.91; loss, 1.

The *Crassamentum* contains the fibrin and coloring matter. Fibrin, known by the names of coagulable lymph and fibre of the blood, is the basis of muscle, and, according to Berzelius, in 100 parts, has Carbon, 53.360; Oxygen, 19.666; Hydrogen, 7.021; Nitrogen, 19.934. The coloring matter contains iron, which is found in the red globules.

MICROSCOPIC EXAMINATION OF THE BLOOD.

FIG. 2.



Under the microscope, numerous little red particles, termed globules, or corpuscula, are observed.

The *form* of the globules varies in different animals; in man and all the mammalia it is circular and flattened, with a cup-like depression on both surfaces, while in birds, reptiles and fishes the form is elliptical.

FIGURE 2. *b* represents the blood corpuscle as seen within the focus of the microscope; *a* shows it when beyond the focus. Magnified 400 diameters.

The *size* varies equally with the form. In amphibia they are regarded as the largest; in birds and fishes next in size, and in mammalia smallest. The human globules are about one-fourth the size of those of the frog. They are larger in the embryo than the adult, and are made to measure from the 1-5000 to the 1-3000 of an inch, though the size often varies. The globules or corpuscles of the frog show, under the microscope, that their structure consists of a membranous envelope—thin, transparent and vesicular—enclosing a nucleus, seemingly solid, and having the colored matter surrounding this nucleus and placed between it and the envelope. The nucleus is regarded as about one-third of the length of the corpuscle. The envelope is found to be highly elastic, and both it and the coloring matter are considered to be quite soft and yielding in their nature.

The *structure* of the human globule is believed by some to have a similar envelope, nucleus and coloring substance, as in the frog, though others consider it extremely questionable whether the blood corpuscle in man, or any of the mammalia, have any nucleus at all, and are therefore disposed to deny its existence in these animals. The nucleus is generally seen in the centre of the corpuscle. Besides the red corpuscle, there is another kind called the *pale* or *colorless corpuscle*. These are found to be fewer in number, larger, and to vary less in size and shape than the red. As their name implies, they are destitute of color and specifically lighter than the red.

The globules are suspended in the liquor sanguinis, their natural fluid, without alteration. Water dissolves the coloring matter, leaving the nucleus; acetic acid changes the form as well as dissolves the coloring matter; and liquor potassæ dissolves both coloring matter and nucleus.

Thus the blood is seen to consist of many chemical and microscopical elements, each and all of which are adapted the one to the other, in precise and definite proportions, to constitute health; and to add to, abstract from or alter in any way the natural relation between any two or more,

would be to produce disorder and disease, primarily in the blood itself, and secondarily in the organs.

VITAL PROPERTIES AND RELATIONS OF THE BLOOD.

Dr. John Hunter stands prominent in demonstrating the vitality of the blood. The analogy of the fresh egg furnished one of his strongest proofs, showing that vitality can be connected with the fluids where there is no visible organization present.

The fresh egg may be exposed for weeks with impunity to a temperature that would certainly putrify the stale egg. The hen, whose period of incubation is three weeks, keeps her eggs at a temperature, it is said, of 105 degrees, yet when the chick is hatched the yolk is perfectly sweet.

This remarkable power of resistance to heat in the fluid of the egg, could be attributed to nothing but its vitality. Its power of resisting cold is equally great. Mr. Hunter exposed an egg to 17° and 15° of Fahrenheit, and found it took half an hour to freeze it. When thawed and again exposed to a temperature of 25° it froze in one half the time.

A fresh egg, and one previously frozen and again thawed, were placed in a cold mixture of 25° Fahrenheit: the egg that had been frozen was again frozen 25 minutes sooner than the fresh.

Fresh drawn blood, and blood that had been frozen and then thawed, by similar experiments, showed the same results—all leading to the same inference of the blood's vitality.

Another proof of the blood's vitality, is its preserving the fluid state while circulating in the vessels; for, on being removed from the body, coagulation, it is well known, very soon occurs. And it occurs, not because the blood is at rest and ceases to circulate, for experiment shows that if it be kept at the same temperature; and have the same rapidity in a dead tube as in the living, it will still become solid, proving that its fluidity in the body must be owing to vital agency.

Coagulation of the blood itself has been brought forward as a proof of its vitality; for from the experiments of Hunter and Magendie, neither cold nor heat, rest nor motion, nor any other known agency, seems to prevent the blood from coagulating. This process is therefore regarded as vital.

The *Automatic motion*, observed among the blood corpuscles, is thought to be further proof of the blood's vitality. This motion, however, by others is considered a delusion.

The last proof we shall here present of the blood's vitality, is its vivifying influence on the whole body, which point illustrates its vital relations.

There is no part of the body where the blood does not circulate, and in which it is not distributed; hence every portion must be directly related with it. And so close is this relation and dependency, that if, by ligature, amputation, or any other cause, the blood be prevented from reaching any organ or part, that organ or part will inevitably die. But allow the blood to circulate in and through it, and it becomes refreshed, and exhibits again all the sensible proofs of vitality.

Hence the necessary inference, that vitality must be connected with the blood—that this vitality is conveyed in the round of the circulation to every portion of the body—and further, that all the solids themselves owe the existence and continuance of their own vitality to the supply of this fluid.

The Formation of the *Blood* is the last point we propose to notice:

The Chyle and Lymph are the great sources from whence the materials for the formation of blood are derived.

The Chyle, formed from our food and drinks by the process of digestion, and found in the upper part of the small intestine, is taken from thence by the Lacteals, and, through the thoracic duct, conveyed into the circulation, and thence on to the Lungs, where its formation into blood is finally effected.

Organs are regarded as the special instruments or means for the formation of blood in the higher order of animals.

As, for instance, the Lungs give the blood its color—here elements are thrown off and others received. The digestive tube, as already mentioned, performs the initiatory steps in its formation—and the organs of excretion are so many purificators in the process.

But we have blood formed where there is no organ or set of organs to account for it—as in the egg. All we see is the germinal membrane, which has the power of assimilating the fluids of the egg to itself, and converting them both into blood and organized vessels.

"This fact," says Professor Muller, "teaches us that we must not expect to discover the process of the formation of the blood and red particles in any special organ of the adult." "Indeed," he continues, "it is very probable that in the adult the chyle is converted into blood under the same general vital conditions which are in action in the incubated egg." From this it would seem that nature has not assigned the formation of the blood solely to any particular part or organ of the body. But, in the language of Dr. Stevens, "when more agents than one are concerned in the production of certain effects, we ought not to consider any one link in the chain as the sole cause, for all the animal functions act in a circle, and are mutually dependent upon each other."

CHAPTER III.

THE CELLULAR TISSUE.

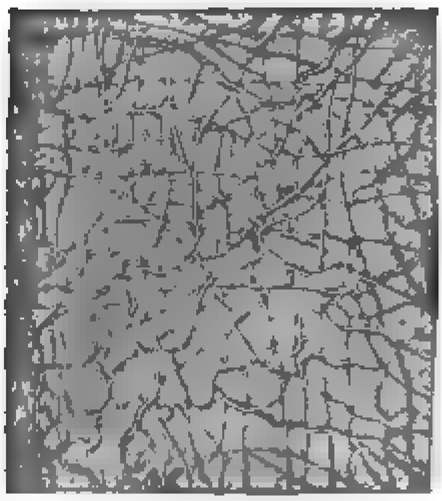
ANALYSIS.

STRUCTURE, EXTENT, FORM, QUANTITY, CONSISTENCY, CONTINUITY—EXTERNAL AND INTERNAL CELLULAR TISSUE—RELATIONS, USES, DEVELOPMENT.

CELLULAR Tissue (called also Areolar and uniting Tissue) consists of filaments of white, soft layers, intermixed and interwoven in different ways, so as to form an arrangement

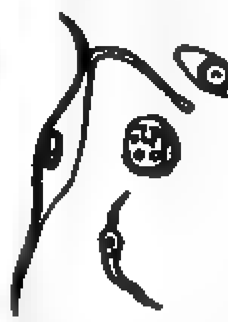
of cells—hence the name Cellular—these cells are of varied size and shape, and all communicate.

Fig. 3.—a



The most beautiful specimen of this tissue is seen in the anterior mediastinum after throwing back the sternum. Here the cells are very distinct, though in other places they are so compact as to appear membranous. The *extent* of the cellular tissue is commensurate with that of the entire body and its various organs. It is found beneath the common integuments, as extensive as the skin itself, forming a general external layer, called the subcutaneous cellular tissue. It likewise surrounds every organ, and every part and fibre belonging to each organ. In a word, there is no part where it is not to be seen; and it may very properly be termed the matrix or soil in which germinate and expand all the other structures.

b



Bordeu, in consequence of its peculiar connections, styles it a Cellular atmosphere.

The *form* of this Tissue, as just stated, is Cellular, but in addition to this special form, it has another and more varied one, which it derives from its intimate relationship with the whole body and its different parts, so that if this Tissue could be separated entire from every part and organ, it would present a perfect outline of the whole system. It would then be seen to form a series of moulds or chambers, each varying in size, and adapting itself to the organ to be accommodated.

Around the fasciculi of muscle, it takes the form of little tubes, as numerous as the muscular fibres themselves—connected with hollow organs, it puts on the form of a mem-

Fig. 3. *a* Arrangement of fibres in Areolar Tissue—magnified 135 diameters. *b* Cells being developed into Cellular Tissue.

branous cavity—and around glands and their granules, it is more or less round.

The *quantity* of this tissue varies according to its situation in the body, and the period of life in which it is examined.

In the cranium and spinal cavity, there is very little; on the surface of the head and face and in the orbits, there is more; about the trunk, both externally and internally, it is abundant, and particularly in the mediastinum, within the thorax, around the kidneys and rectum, and within the abdomen and pelvis. In the extremities it is also abundant, particularly in the axilla and groin.

The quantity seems to be regulated as a general rule, according to the motion of the part—the greater the motion, the more of this tissue is present; the kidneys, rectum and some other parts, it is true, are exceptions.

The quantity in infancy is greater than in the adult—it is also more abundant in women than in men—and in the lymphatic than in the bilious temperament.

The *consistency* equally varies with the quantity—but the firmness is not found in a ratio with the quantity—as in the mediastinum and around the kidneys, where it exists in large quantities, it is exceedingly fine, delicate, easily torn, and having but a slight degree of consistence; whereas, in the *fascia lata* of the thigh, the palmar and plantar fascia of the hand and foot, it presents an extraordinary firmness and degree of strength.

The *continuity* of the cellular tissue can be traced throughout the body. The foramina of the cranium are the means of communication between the internal and external portions of the head and face—from the face it is continued down the neck upon the external surface of the chest—then through the upper opening in the thorax, it enters this cavity, covering its different viscera; from this it descends along the œsophagus and through the openings in the diaphragm, into the abdomen and pelvis, from whence it is traced under the crural arch and foramina of the pelvis, continuous with that belonging to the extremities.

It has been divided into the external and internal cellu-

lar tissue, the former giving the general covering to the body, surrounding, separating and connecting its different parts, while the latter enters into and forms an essential part of their structure.

The *relations* of the cellular tissue are of two kinds—the one with organs, one of whose surfaces is free, as the skin, serous and mucous structures, and the other with organs where the attachment is all around.

The adhesion of this tissue varies in different parts. Beneath the hairy scalp, it is with difficulty separated from the aponeurosis and muscles below—and along the middle line of the body, as upon the nose, the lips, linea-alba, and spinous processes, it is considered more adherent than at any other points—while in the face, trunk and extremities it is quite free and loose.

The cellular tissue allows, by its properties of elasticity and flexibility, the movements of the several parts to be performed readily, the one upon the other—which properties themselves are preserved by the presence of the serum within its substance.

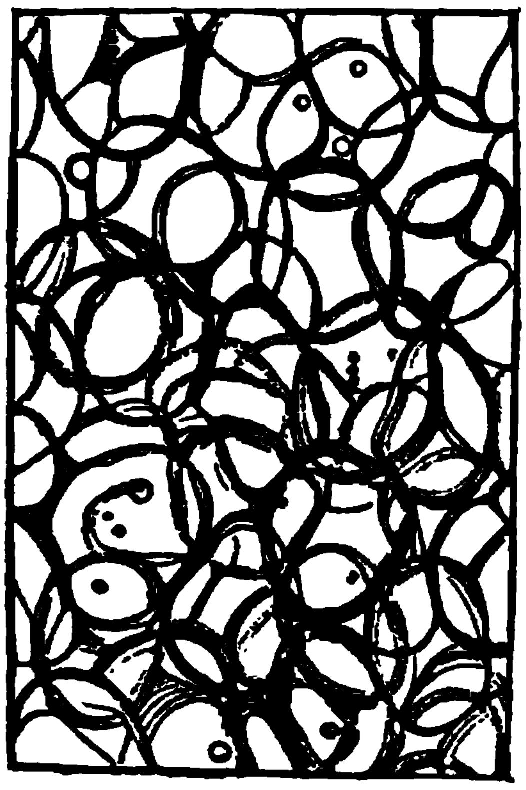
In addition to its mobility, this tissue has other uses. The mucous membrane, as that of the stomach, intestines and bladder, connects with the muscular fibres that surround it—and in the serous membranes it permits that expansion and easy motion we observe in many of the viscera.

The organic element of cellular tissue, is mostly gelatin. Its *development*, from microscopic observations, commences with the nucleated cell, which becomes transformed and elongated into fibres, and finally into a fasciculus of extremely delicate fibres.

It is readily regenerated when destroyed.

ADIPOSE TISSUE.

FIG. 4.



The fat was formerly supposed to be a secretion from the cellular tissue, and that its cells were the places of deposit. The opinion of Hunter and Beclard, that there was a distinct apparatus for this secretion, the microscope now proves to be correct.

It reveals the vesicles or cells (fig. 4) entirely distinct from those of the cellular tissue, in having no communication, and by retaining the fat in their sac-like shape, so as to completely prevent its changing its place, as is the case in the fluids of the cellular tissue.

The fat cells are found scattered at wide intervals, in the cellular tissue, and also collected in clusters at different points in this same structure.

Indeed they are almost commensurate with the cellular tissue, if we except the interior of the cranium, the ball of the eye, the ear, the nose, the penis, the eyelids, and the substance of glands, where they are wanting.

The parietes of the fat vesicle are very delicate and surrounded with blood vessels, forming a net work, from which is secreted the fat deposited in the cell.

The fat exhibits striking differences at different periods of life. In the fœtus and infancy, it is more liquid and transparent than in the adult, when we find it more firm and of a yellowish color.

Its quantity, as regards position, is just the reverse in certain organs in youth and adult age.

The skin of the infant abounds with fat, causing the roundness and plumpness so constant at this period—while observations show there is very little about the heart, kidneys, omentum, rectum, and other internal parts.

FIG. 4. Exhibits the cells of adipose tissue—magnified 135 diameters.

In the adult, on the contrary, the fat lessens in quantity and in many instances entirely disappears from beneath the skin—while it collects in large quantities about the heart, kidneys, omentum, &c.

The *uses* of the fat vary with its situation. Beneath the skin, it covers the projections of bones, thereby increasing the rotundity and adding beauty to the form. In the orbits it serves as an elastic cushion for the eye to roll upon. In the palms of the hands and soles of the feet, it prevents injury to the skin from pressure—and in being a bad conductor of caloric, it assists in preserving the body of uniform temperature, while in nutrition, it is regarded as the great store-house of supply, during the wasting process of protracted disease.

THE SEROUS TISSUE.

ANALYSIS.

IDENTITY WITH CELLULAR TISSUE, FORM, DIVISIONS, REFLECTIONS, STRUCTURE, FUNCTIONS.

The serous tissue has been brought under the same head with the cellular, being regarded by the highest authorities as a modification of the same.

The inflation of the subjacent cellular texture with air, reduces the serous membrane to the same form—protracted maceration has the same effect with greater certainty: when the cellular tissue is inflated, the parietes of the cell strongly resemble the finest parts of the serous tissue—as seen in the arachnoid membrane.

There is a further identity of functions and affections—exhalation and absorption being performed in each, and dropsy passing, it is said, readily from the one to the other.

The form of the serous tissue is that of a shut sack. It is divided into—

1st. The serous tissue proper, as the peritoneum, plura, tunica arachnoids, and tunica, vaginalis, situated in the abdomen, thorax, cranium, and upon the testicle.

2d. The synovial membranes.

3d. The bursæ mucosæ.

The *form* of the serous tissue has been stated to be that of shut sacs—this is true of all except the peritoneum of the female, which is open at the extremity of the fallopian tubes. These sacs all line the various cavities in which they are found, and are thence reflected upon the various organs and viscera. These reflections have different names, according to their situation, uses, attachments, &c., as the omentum gastro-hepaticum or minus, omentum gastro-colicum or majus, gastro-splenicum, mesentery, meso-colon, meso-rectum, the ligaments of the liver, the broad ligaments of the uterus, the ligaments of the bladder, &c., all of which are the names of so many reflections of peritoneum, illustrating its position and connection with the stomach, liver, intestines and other organs.

The serous tissue, with some few exceptions, forms a complete investment to all the organs and parietes of cavities with which it is connected; that portion surrounding the walls is the parietal, that covering the several organs is the visceral layer. Its continuity as one unbroken membrane, except the female peritoneum, is admitted by all anatomists, and it is said to have been successfully dissected, entire and complete, without the slightest rupture, from the abdominal cavity and its various organs, by one Nicholas Massa.

How the peritoneum, pleura, &c., shall cover the several viscera, and yet these same viscera be upon the outside of its cavity, is often a difficulty with the young beginner in anatomy. The comparison with the double night-cap, is used as an easy and familiar illustration. That part of the cap which covers and fits close to the head, represents the peritoneum covering the different organs, while the portion that floats loose above the head, and is external, represents the peritoneum lining the interior abdominal walls. Now it is plain that the head, though covered by the cap, is not in its proper cavity, but on the outside. And so with the peritoneal sac, all the organs are upon the outside, and

6

obtain a covering by protruding into or pushing this membrane before them into its cavity.

The *structure* of the serous tissue consists of thin, white, transparent membranes, composed, according to Muller, of fibres, like the cellular tissue, collected into bundles, and forming a membrane. It has two surfaces, the one attached, the other free. The free surface is smooth, polished, and constantly lubricated by an albuminous fluid, which thus allows the free motion of the several organs upon each other; and the microscope shows that this free surface is covered by an epithelium, formed of flattened scale-like cells, as the epidermis—polygonal or tesselated, and having each a nucleus in its centre. Some of these cells are seen to elongate into hair-like filaments called cilia, which are in constant vibration, and, as supposed, intended to prevent stagnation of the fluids with which they are in contact.

The *Synovial Membranes* are simply serous sacs of smaller size found about the different joints. They line the internal surface of the capsular ligaments, and are thence reflected upon the cartilages covering the articular ends of the bones. They are also seen under the annular ligaments, around tendons and beneath fasciæ. The synovial fluid differs from the serous in being more viscid.

The *Bursæ Mucosæ* forms the third division of the serous system, and are also modifications of the cellular tissue. They consist of serous sacs, most generally placed between muscles and tendons and bones, and in connection with articular cavities and ligaments. They secrete a fluid for lubricating the parts with which they are in contact. Mr. Hooper enumerates the following: The head has 4; the shoulder joint 11; elbow joint 4; wrist and hands 15; hip joint 12; knee joint 6; the foot 10—making 62 bursæ mucosæ to the whole body, besides others more irregular in their distribution.

The functions of the serous tissue are those of secretion, exhalation, and absorption. The fluid secreted is designed to allow free and easy motion among the several

viscera, between the tendons and bones, and at the several joints. Morbid accumulations of this fluid constitute several varieties of dropsy—as ascites in the peritoneum, hydrothorax in the pleura, hydrocele in the tunica vaginis testis, &c.

A variety of opinions have been entertained as to the uses of the different peritoneal reflections, particularly the omentum majus. But as they are mostly fanciful, we will only mention one, which seems to be the most rational explanation, and that is, that they allow of the free expansion of the organs with which they are connected—as the omentum majus, during the reception of food, permits the safe enlargement of the stomach, and the broad ligaments, during gestation, that of the uterus.

The sensibility of this tissue is remarkably obtuse in the healthy state, but when inflamed causes the most acute pain.

CHAPTER III.

THE VASCULAR TISSUE.

ANALYSIS.

OBJECT, DEFINITION OF CIRCULATION, DIVISION, SITUATION, FORM, ANASTOMOSES, DISTRIBUTION, RELATIONS, DEVELOPMENT.

The great object of the vascular tissue is to convey the nutritive fluid to every part of the body, to supply the materials of its growth and renovation, as well as to remove those of its decomposition and waste. The performance of this duty is styled circulation, from the fact that the blood beginning at the heart and going to every portion of the system, and then back again to the heart, moves as it were in a circle; hence it is said to circulate; and the function itself, as just stated, is called the circulation.

The heart, arteries and veins constitute the parts belonging to the circulation proper—the first being the cen-

tral organ for propelling the blood, the second conveying it to every part of the system, while the third returns it back again to the heart.

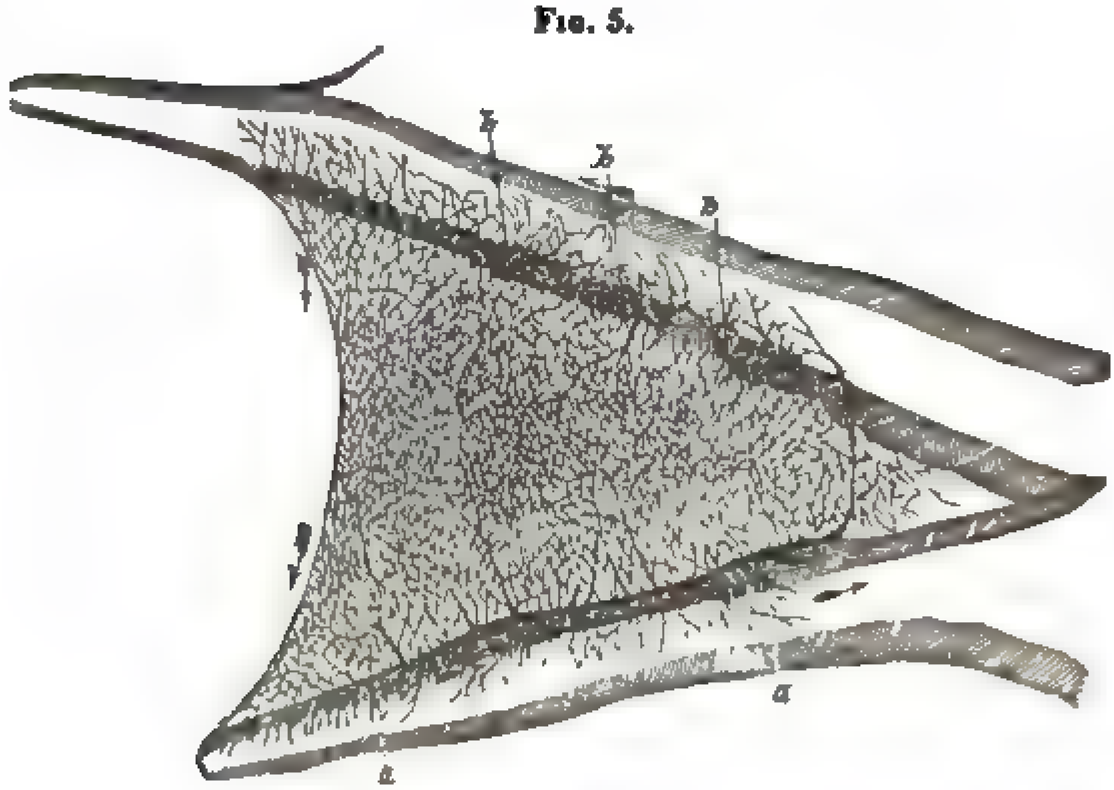
Besides this general circulation, there is also distinguished the pulmonary, the portal, the capillary and the lymphatic circulations.

The vascular tissue belonging to each of these circulations will be examined in the order of their development, which physiology shows to be—

1. The Capillary.
2. The Portal.
3. The General.
4. The Pulmonary.
5. The Lymphatic, an appendage to the blood circulation.

THE CAPILLARY TISSUE.

FIG. 5.



The capillary tissue (from capillus, a hair,) is situated between the arteries and the veins, at the termination of the one and the commencement of the other.

FIG. 5 shows the capillaries between the termination of the arteries and the commencement of the veins in a frog's foot. Magnified three diameters. *aa* the veins; *bb* the arteries.

The precise point of separation is not determined; hence this tissue is viewed as a system of vessels belonging neither to the arteries nor the veins, but one *sui-generis*, and, according to Bichat, independent in its action.

The microscope reveals the capillary tissue to consist of a multitude of very minute, hair-like vessels, having distinct parieties, and assuming the *form* of a net-work. Though this is the general form, there is found to be some variation from the different sizes of the meshes, and from their being elongated or not. The capillary arrangement in the small intestines, according to Soemmering, is arborescent; in the muscles a bunch of twigs; in the tongue a hair pencil; in the liver a star; in the schneiderian membrane a trellis-work; in the choroid plexus of the brain, and testicle, a lock of hair; in the kidneys glomerulate. The capillaries are the minutest tubes in the body, consisting, says Beclard, of thin, soft, transparent walls; and, according to Muller, having a mean diameter of 1.3700 to 1.1850 of an inch, allowing sufficient space for the free passage of the blood globules, which are only from the 1.5000 to the 1.3000 of an inch.

The *structure* of the capillaries is regarded by Schwann as fibrous, the same as the larger vessels, and their contractile power experiments demonstrate to be far greater.

The capillaries are not equally abundant in every portion of the body. The quantity is estimated by injections, congestions and inflammations. An opinion prevailed that the whole body was made up of blood-vessels, from the very minute injections of the celebrated Ruysch. The microscope, however, shows that various parts of the body are more vascular than others, and that there are some entirely destitute of any vessels whatever. The mesentery, or the web of the frog's foot under the microscope, presents its most minute capillaries, those admitting but one globule, as separated by a considerable space, while in the mucous membrane, belonging to the organs of respiration, in the same animal, it has been observed to be impossible to stick a very fine needle without opening several of these

vessels. The skin of man also shows that there is no point on its surface that can be pricked without drawing blood. The mucous membranes are as abundantly, if not more so, supplied with capillary vessels than the skin. The cartilages, epidermis and hair are not penetrated by injection, and show no blood-vessels whatever. The ligamentous structure, the dura-mater, periosteum, &c., have few blood-vessels.

The question here arises, if these parts have few or no blood-vessels, how do they grow and how are they nourished? The answer to this question led Bichat to believe and assert that there was another kind of capillaries besides the sanguineous, which carried the serous or colorless portions of the blood to the white structures, and which he called exhalants. The existence of exhalant vessels has never been satisfactorily demonstrated, though admitted by many to exist. The lymphatic capillaries come under the same head, both of them being considered equally necessary for development and support to the white organs, as the sanguineous capillaries are to all other parts.

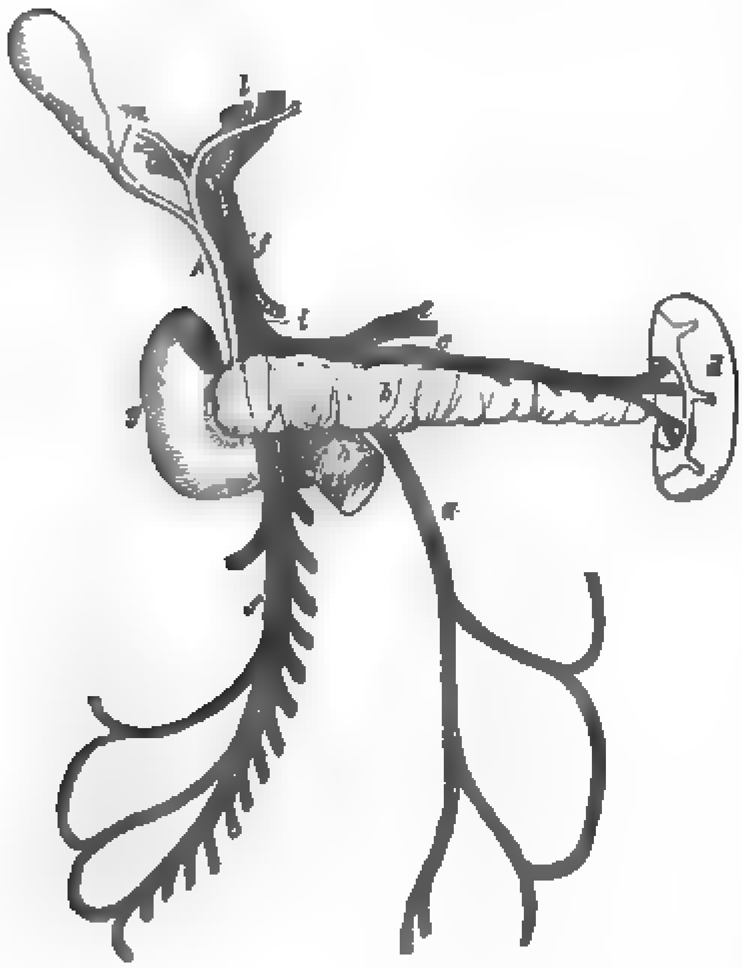
Various agents are capable of acting on the capillaries, producing contraction and dilatation, and these may be mechanical, chemical or mental.

The principal functions of the capillaries are those of nutrition and secretion, and their independent action, according to Bichat, that of carrying on their own circulation without the heart, and also of giving the impulsive power to the veins.

This independent action in the capillary system, if one part of the body can in any sense be said to be independent of every other part, seems most likely true, as there are some animals low in the scale of being, which are entirely without heart and blood vessels, and possess no other kind of circulation but the capillary, which is regarded as the primitive or fundamental circulation.

THE SECOND OR PORTAL SYSTEM OR CIRCULATION.

FIG. 6.



The portal by some physiologists, is considered the primary circulation.

Meckel remarks, "we are deficient in exact observations relatively to what parts of the vascular system are formed first, either in man or in the mammalia. Nevertheless, we may admit, as almost certain, that the veins appear before the arteries, and that the first are those of the umbilical vesicle—for it is proved in birds that the vitelline veins, and particularly the omphalo-mesenteric, are soonest developed. Now, the umbilical vesicle, in man, corresponds exactly with the vitelline sac of birds."

"As to the mode of development of the vessels," continues this Anatomist, "we learn the following from what occurs in the egg. When at some distance from the embryo, we see in the membrane of the yolk, which is at first homogeneous, certain rounded, circumscribed rents, which are filled with a mass more fluid. These rents are at first entirely separated from each other, and appear like islands in the

FIG. 6. The vena-portarum—*a* inferior mesenteric vein. *b* The pancreas. *c* The splenic vein. *d* The spleen. *e* Gastric veins uniting with the splenic. *f* Superior mesenteric vein. *g* Descending portion of duodenum. *h* Transverse portion. *i* Vena portarum. *j* Hepatic artery. *k* Ductus communis, choledochus. *l* Division of vessels and duct at the transverse fissure of the lever. *m* Cystic duct.

rest of the mass—new lacunæ are gradually formed in the substance of the membrane of the yolk, which increase the number of islands, and give rise to a fine net work of vessels, which ramify exceedingly—these soon contain real blood, instead of the clear, thin fluid which first filled them. This vascular net-work is the commencement of the omphalo-mesenteric vein—its trunk is not the first portion formed, but the ends of the vessel appear soonest, these gradually unite into branches and finally produce the trunk. When the omphalo-mesenteric vein is thus once formed, the rest of the vascular system produces itself as follows:

"The vein bends from below upwards, and dilates on the anterior face of the body of the fœtus to form the heart. From this the trunk of the arteries of the body arises, which carries the blood to the organs, and after this we see the accompanying veins. The vessel into which the omphalo-mesenteric vein opens, or to speak more exactly, into which it is changed, is the vena portæ. This, which at a later epoch finds itself simply enclosed in the general system of the veins of the body, constitutes at present the principal trunk, and at its upper part produces the heart."

The portal system, in connection with the general and pulmonary, have each a common *form*, which is compared to a tree consisting of a trunk, branches, twigs, and ramuscules. The portal, *situated* entirely within the abdominal cavity, has its trunk about three inches in length, lying between the duodenum and the liver. Its roots are the numerous capillaries arising from the small and large intestines, the stomach, pancreas, and spleen, while the almost endless divisions and subdivisions in the liver, are the different branches and twigs of the tree. The liver is viewed as the centre of this circulation.

The *structure* of the portal vessels consists of three membranes, an external, middle, and internal. The first is a condensed cellular tissue, not so strong as in the arteries. The second is fibrous and contractile, and by some considered muscular, having its fibres running longitudinally; while the third is a delicate serous membrane, having a smooth

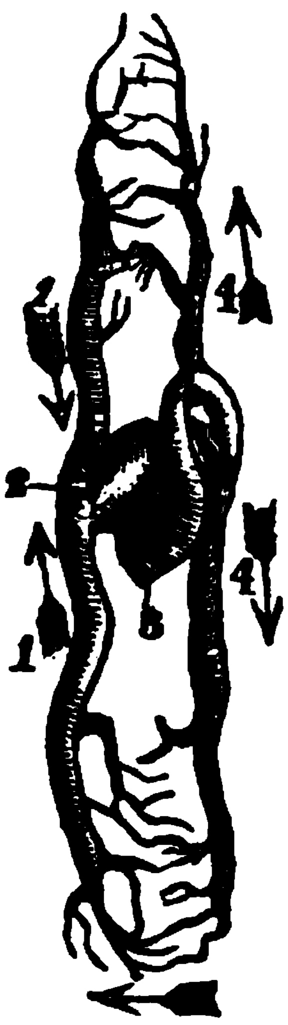
polish, and, according to Henle, an epithelium composed of vesicles and scales, analogous to those of serous and mucous membranes.

The portal vessels are veins, but differ from other veins in not having any valves. They are endowed with the properties of contractility, extensibility, and elasticity.

Their *function* is to convey venous blood, of the darkest kind, from the abdominal digestive organs, except the liver, to this gland, where the bile is separated from it. The *ductus venosus* is the connecting link between the portal and the next or general circulation.

THE THIRD OR GENERAL CIRCULATION.

FIG. 7.



The general circulation is styled the true, or Circulation Proper.

It commences in the left ventricle of the heart by the aorta, extends and ramifies through every part of the body, and then returns, by the vena cava, back again to the heart upon its right side, thus completing the circle. From this mode of distribution, we have the *form* of two trees—one the aorta, the other the vena cava—the former carrying the blood from the centre to the circumference, the latter bringing it back changed, from the circumference to the centre. The heart is the centre.

The heart, arteries and veins, then, comprise the three natural divisions of the general circulation.

M. Bichat makes two great divisions of this circulation.

1st. The vascular system of red blood.

2d. The vascular system of black blood.

The first division commencing in the lungs, with the red

FIG. 7 represents the blood moving in a circle. 1, 1, Superior and Inferior Cava. 2, Right Auricle. 3, Left Ventricle. 4, 4, Aorta and common Carotid Artery.

blood, by the pulmonary veins, proceeding from thence to the left side of the heart, thence by the aorta, to every part of the body. The second division beginning with the black blood, in the extremities and circumference of the body, and proceeding thence to the lungs, its place of termination.

It will be seen that this mode of division includes another and distinct circulation in the lungs, to be noticed in another place.

The *direction* of the vessels belonging to the vascular system, with some exceptions, is generally straight, and proceeds in right lines.

All its different divisions have free communication, the one with the other, as the capillary, portal, general, and pulmonary. So likewise with the several parts composing each division. This mode of connection is called *Anastomosis*, (from ανα, through, and ϛομα, mouth,) where the vessels open like mouths, and run into each other. By means of injections, the arteries are often traced into the veins—the lymphatics also; thus demonstrating the free intercourse between the arterial, venous, and lymphatic systems.

J. F. Meckel points out three different forms of anastomosis in the arteries:

1st. Where two arteries run into each other and form an arch, the place of union not being known. This is the most common form, and is always found at the different articulations, and among the branches of the mesenteric arteries in the abdomen. A most striking example of this form is the beautiful curve formed by the union of two branches of the superior and inferior mesenteric arteries, called the great meso-colic arch, and a hundred similar arcades can be seen in the intestinal arteries.

The 2d form of anastomosis, is where two vessels unite by a small transverse branch, as in the anterior and posterior cerebral arteries forming the circle of Willis, and in the pulmonary artery and aorta joined by the ductus arteriosus.

The 3d form is where two vessels come together at an acute angle, to form one common trunk, as we see at the

base of the brain, where the two vertebrals unite to form the basilar artery.

The utility of this arrangement, by anastomosis, between the different divisions of the vascular system and the different parts of each division, is strikingly seen in the safety it confers, in the numerous accidents and operations to which the human frame is daily subject. As, for instance, when the main vessel leading to either extremity, as the femoral or axillary artery, shall either by accident, disease, or an operation, be divided or become obliterated, the limb would necessarily die, were it not for this wise provision of nature, in making the branches which go off from above and below the point of the injured vessel, come together, and thus carry on the circulation.

The structure of the arteries, as of the vena portæ, consists of three membranes or coats, an external, middle, and internal. The external is condensed cellular tissue, very strong and resisting, composed of filaments closely bound together, never containing any fat, and connected with the surrounding parts. The middle coat, called also the muscular, is regarded as the proper arterial tunic. Its fibres are yellowish, brittle, elastic, and contractile. They surround the artery in a circular manner, though not forming complete rings, and are considered by many as essentially muscular in their character. The microscope divides this middle coat into three laminæ, an outer, yellow, thin, elastic—a middle of circular muscular fibres, and an inner of muscular, but longitudinal fibres; hence this peculiar combination of structure and properties in this middle coat explains how it is that when an artery is dilated, it returns by its elasticity to its former natural state—and how, from its muscularity, it can be so contracted as to entirely destroy its diameter and arrest the circulation. The experiments of Mr. Hunter, as well as the daily operations of the surgeon, conclusively establish the power of contraction in the arteries.

A circular section made in the aorta of a horse bled to death, measured at first five inches and a half, on being

stretched it reached to ten inches and a half, and when let alone it contracted to six inches, when it became stationary; the difference between six and ten and a half inches, is the measure of its elastic force, while half an inch is due to muscular contraction.

Mr. Arnott makes the following statement, proving the contractility of the arteries. 1. A small living artery cut across, soon contracts so as to close its canal and arrest hemorrhage; 2. While an animal is bleeding to death, the arteries, accommodating themselves to the decreasing quantity of blood, contract far beyond the degree to which their simple elasticity would carry them. 3. The artery of a living animal, if exposed by dissection to the air, sometimes will contract in a few minutes to a great degree, and in such a case only a single fibre of the artery may be affected, narrowing the channel like a thread tied round it. 4. When a living artery is tied, the part between the ligature and the nearest branch on the side of the heart, gradually contracts and becomes at last a solid and impervious cord. The property of contractility in the arteries is admitted by all, but that it is due to muscular structure is the point in dispute. One point of distinction, as mentioned between the contraction of arteries and that of muscle, is that the former cannot be excited under the strongest electric and galvanic stimuli, while the muscles can.

Elasticity has been stated to be another property of the middle coat, by which, if the artery be contracted too much, it will dilate, and if dilated too much it will again return to its natural size—and upon this property, combined with the muscular contractions of the heart, depends the jetting of the blood observed in the arteries.

The internal coat of an artery is smooth, resembling serous membrane, and a continuation of that lining the cavity of the heart, which by its duplication forms the valve found at the mouth of the aorta and pulmonary artery. This coat is connected to the middle by fine cellular tissue, and in advanced age is often subject to ossification or calcareous concretion.

The arteries, in addition to their three coats, are supplied with nutrient vessels, vasa vasorum, as well as nerves from the neighboring parts. They are also surrounded by a cellular covering called the *sheath* of the artery.

The *veins* consist of the same number of coats as the arteries, though much more delicate and weak in their structure, and readily collapse when empty or divided. The middle coat is decidedly muscular at the entrance of the larger veins into the heart, and the difference between this coat and that of the arteries is, that while the fibres are chiefly circular in the arteries, they are mainly longitudinal in the veins, which distinction in the arrangement of the muscular fibres of these two kinds of vessels, has been considered a fundamental and essential point in the physiology of circulation.

The inner coat of veins is also serous, and continuous with that lining the cavity of the right heart. Its great peculiarity is in having valves—formed by its duplication—whose free edge looks towards the heart; they consequently favor the onward circulation of the blood, while they as effectually hinder its retrograding.

Each valve has a semi-circular shape, is connected by its convex edge to the interior surface of the vein, which, being dilated at this point, presents a knotted appearance. These valves are most numerous in the extremities, and more abundant in the superficial than the deep-seated veins. They exist generally in pairs—three have been found together, and sometimes there is only a single one, as at the mouths of the coronary vein, vena azygos, and vena-cava ascendens. They are absent in the large trunks, as the venæ cavæ, venæ innominatæ, internal jugulars, iliacs, portal veins, and the sinuses of the brain.

The veins have their vasa vasorum, like the arteries. They also possess the properties of contraction and expansion, and are, in some measure, elastic.

DISTRIBUTION OF THE ARTERIAL TREE.—(FIG. 8.)

We only purpose, in this place, giving a general outline of the arterial tree, or a rapid summary of its primary branches, reserving the detail for a more appropriate place.

B. Ascending Aorta—its branches,
1. The right Coronary Artery.
2. The left Coronary Artery.

C. Arteria Innominata.

DD. Subclavian Artery—branches,
1. The Vertebral Artery.
2. Internal Mammary.
3. Inferior Thyroid.
4. Cervicalis Ascendens.
5. Transversalis Colli.
6. Transversalis Humeri.
7. First and second Intercostals.
8. Supra Scapularis.

EE. Axillary Artery—branches,
1. Superior Thoracic.
2. Thoracica Longa.
3. Thoracica Acromialis.
4. Subscapularis.
5. Circumflexa Posterior.
6. Circumflexa Anterior.

FF. Brachial Artery—branches,
1. Profunda Superior.
2. Anastomotica Major.

G. Radial Artery—branches,
1. Recurrens Radialis Anterior.
2. Superficialis Volæ.
3. Arcus Profundus, h. Arteria Dorsalis Pollicis.

H. Ulnar Artery—branches,
1. Recurrens Ulnaris Anterior.
2. Recurrens Ulnaris Posterior.
3. Arteria Dorsalis.
4. Arcus Superficialis.
5. Digital branches—a, b, c, d, e, f.

I. Interosseous Artery—branches,
1. Interossea Superior Perforans.
2. 2d Interossea, from the right Radial Artery.

K. Com. Carotid Artery—divided into

L. External Carotid—branches,
1. Superior Thyroid.
2. Lingual.
3. Facial.
4. Occipital.
5. Posterior Auricular.
6. Internal Maxillary.
7. Transverse Facial.
8. Temporal.

M. Internal Carotid—2d division of common Carotid—branches,
1. Anterior Cerebral.
2. Middle Cerebral, Arteria Media Cerebri.
3. Arteria Communicans.

N. Vertebral Artery—branches, Anterior and Posterior Cerebellar Arteries.

O. Basilar Artery—branches,
1. Arteria Communicans.
2. Posterior Cerebral.

P. Thoracic Aorta—branches, 1 to 10, the Intercostals.

Q. Abdominal Aorta—branches,
1. Phrenic Artery.
2. Cœliac—dividing into
3. Gastric, $\left.\right\}$
4. Hepatic, $\left.\right\}$ Arteries.
5. Splenic, $\left.\right\}$
6. Superior Mesenteric.
7. Renal Capsular.
8. Emulgent.
9. Spermatic.
10. Inferior Mesenteric.
11. Lumbar.
12. Middle Sacral Artery.

R. Common Iliac Artery, divided into

S. Internal Iliac—branches,
1. Obturator.
2. Glutial.
3. Ischiatic.
4. Internal Pudic.

T. External Iliac—2d division of common Iliac—branches,
1. Epigastric.
2. Circumflexa Ilii.

U. Femoral Artery—3. Profunda Femoris—branches,
1. External Circumflex.
2. Internal Circumflex.
3. Perforantes.

V. Popliteal Artery—branches,
1. Superior External Articular.
2. Superior Internal Articular.
3. Middle Articular.
4. Inferior External Articular.
5. Inferior Internal Articular.

X. Anterior Tibial Artery—branches,
1. Recurrens Tibialis.
2. Internal Malleolar.
3. External Malleolar.

Y. Posterior Tibial Artery—branches,
1. External Plantar.
2. Internal Plantar.

a, b, c, d, e, f, digital branches.

Z. Fibular Artery—branches,
1. Anterior.
2. Posterior.

FIG. 8.

NOTE.—The Arteria Innominata, (C,) which generally divides into the right Carotid and right Subclavian, gives off in this instance; also the left Carotid. The Brachial Artery (F) on the left side will also be seen to have a high bifurcation.

The aorta, the great trunk of this tree, has its origin in the superior part of the left ventricle of the heart, ascends behind the pulmonary artery to the right side, on a level with the articulation of the second rib with its cartilage, then crosses transversely about an inch below the upper edge of the sternum to the left side, where it makes a second turn downwards and inwards to the bodies of the third or fourth dorsal vertebræ. This course of the aorta describes a curve called its *arch*, consisting of an ascending, transverse, and descending portions. From the arch we follow the aorta descending through the thorax upon the left side of the vertebral column to the diaphragm, beneath the crura of which muscle it passes, and thence continues to descend on the median line to the space between the fourth and fifth lumbar vertebræ, where it terminates, dividing into the common iliacs.

The portion above the diaphragm, beginning with the arch, is called the thoracic aorta—the portion below is the abdominal aorta.

The first branches given off by the aorta after leaving the heart, are the coronary arteries—two in number—the right and left, which supply the right and left portions of the heart. The next in order are those coming off from the arch, which are the arteria innominata, the left carotid, and the left subclavian. These are large and important branches, supplying, with arterial blood, the head, neck, and superior extremities. The arteria innominata, after proceeding about an inch and a quarter, divides into two branches, the right carotid and the right subclavian. The former passes up the right side of the neck to opposite the corner of the os-hyoides, where it again divides into the external and internal carotid arteries, the former supplying the right side of the face and the right and posterior parts of the head, together with the right upper neck, while the latter enters within the cranium and supplies the right half of the brain.

The left carotid, arising from the arch of the aorta, pursues a similar course upwards upon the left side of the

neck, has a similar division at the os-hyoides, into external and internal carotids, supplies with a like number of branches the left upper half of the neck, face, side and posterior parts of the head; while the left internal carotid supplies the left half of the brain.

The whole number of branches, of any magnitude, which belong to the carotids upon both sides of the neck, are about 22; 16 of this number going to the upper neck and exterior head, while the remaining supply the brain.

The subclavian artery, having its origin on the right side from the arteria innominata, and on the left from the arch of the aorta proceeds in the first stage of its course to the scaleni muscles, between the anterior and middle of which it passes. It then proceeds between the clavicle and first rib to the tendons of the latissimus dorsi and teres major muscles, over which it passes, completing the second stage of its course. We now follow it down the arm along the inner edge of the biceps muscle, upon the brachialis anticus to a little below the elbow joint, forming its third and last stage, where it divides into the radial and ulnar arteries, which supply the forearm and hand. These three stages have received distinct names—the first stage is called the subclavian, the second the axillary, the third the humeral. Five branches belong to the first, eight to the second, and six to the third stage. The whole number of primary branches belonging to the two subclavian arteries, which supply the upper extremities, is about 38.

The chest and its organs are next in order as we proceed down the body and follow the course of the arterial trunk.

The aorta having made its curve, gives off the bronchial arteries to the lungs; the œsophageal branches, five or six in number, to the œsophagus; posterior mediastinal branches, as the name imports, to the mediastinum; and ten intercostal branches to the intercostal spaces and walls of the chest—the two upper intercostal spaces being supplied from the subclavian. These arteries being all in pairs, the whole number supplying the chest is about 40.

The aorta having passed the diaphragm, becomes abdominal and distributes its branches in the following order. 1. The *phrenic*, two in number, to the diaphragm. 2. The *cœliac*, a single trunk, which divides into three branches that supply the stomach, liver and spleen, called the gastric, hepatic and splenic arteries. 3. The *superior mesenteric*, about half an inch below the cœliac, sends off innumerable branches which go to the small intestine, and the ascending and transverse portion of the large. 4. The *emulgent* arteries come from the aorta at right angles, and go to the right and left kidneys. 5. The *spermatic* going to the testicles, are small and of great length. 6. The *inferior mesenteric* is a single trunk, supplying the left colon. 7. The *lumbar* arteries, from three to five in number, supply the walls of the abdomen. These are all the primary branches given off by the abdominal aorta to its termination, and are about 19 in number. The whole number sent off by the arterial trunk from its commencement to its termination, counting the two terminating branches, is about 66—five from the curve, forty from the thoracic, and twenty-one from the abdominal aorta.

The aorta, as already stated, terminates at the space between the fourth and fifth lumbar vertebræ, from whence proceed the common iliacs, which go to the sacro-iliac symphysis, and there divide into two main branches, the internal and external iliac arteries. The former supply the pelvic cavity and its viscera, the latter go to the inferior extremities.

The principal branches of the internal iliac or hypogastric artery are, 1, the ilio lumbar; 2, the lateral sacral; 3, the obturator; 4, the middle hæmorrhoidal; 5, the uterine peculiar to females; 6, the vesical; 7, the gluteal; 8, ischiatic, which go to the rectum, bladder, vesiculæ seminales, prostate gland, and walls of the pelvis, while the same branches supply the vagina, uterus, ovaries and common parts of the female.

The external iliac artery is so called till it reaches Poupart's ligament, when it becomes *femoral*. It gives off but

two branches in its course, and these at its termination: 1, the epigastric, and, 2, circumflexa ilii.

The femoral artery, commencing at Poupart's ligament, is to be found at a point half way between the anterior superior spinous process of the ilium, and the symphysis pubis, situated behind this ligament and upon the common union of the psoas magnus, and iliacus internus muscles; thence it crosses the pectinalis, adductor brevis and longus, along the inner edge of the rectus, and behind the sartorius to the tendon of the adductor magnus, which it perforates. There it becomes popliteal and continues such to the aperture in the interosseous ligament of the leg, where it divides into anterior and posterior tibial arteries, supplying the leg and foot. The femoral arteries give off each four principal branches to the thigh; the popliteal, five to the knee-joint, and the two terminating branches of the popliteal, to the leg and foot. The whole number of primary branches supplying the lower extremity, is about 28.

The whole number to the body is 132—66 to the trunk, and 66 to the extremities.

This is the most usual way in which the arterial system is distributed, but we shall frequently find *varieties* in the origin, course, size, and number of the primary branches.

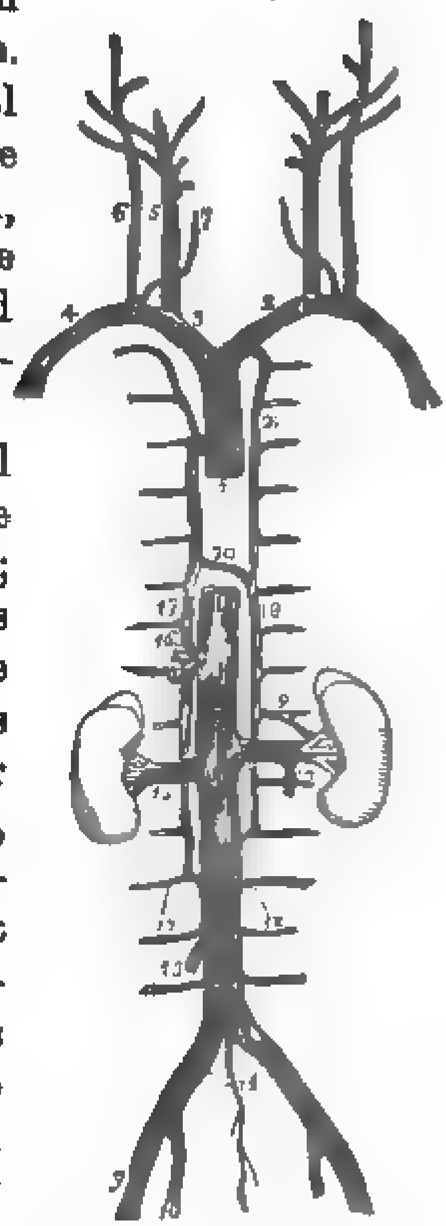
The *venous tree* has its commencement where the arterial terminates, or more properly, from the capillaries, the connecting link between the two. The venous system consists of two trunks, called the inferior or ascending, and the superior or descending cava.

These two trunks, with the coronary vein, return to the heart all the blood of the body. We trace the primary branches of the venous trunks in a direction contrary to the arterial, that is, from the circumference to the heart, instead of from the heart to the circumference.

In the inferior extremity, commencing in the foot, we trace the venous radicles, forming the superficial and deep-seated veins.

The superficial are the external and internal saphena, the former rising upon the anterior and external part of the

Fig. 9.



dorsum of the foot, the latter upon the internal and plantar portion. After free anastomosis, the external ascends upon the outer side of the leg and terminates in the popliteal, while the internal runs up on the inner side of the leg and thigh, and ends in the femoral vein, a short distance below Poupart's ligament.

The deep-seated veins have all the same course, and the same name with the arteries they accompany; every artery except the larger trunks having two veins called the venæ comites. Hence we follow the veins attending the anterior and posterior tibial arteries, with the peroneal, ascending the leg and by their common junction at the posterior part of the knee joint, forming the popliteal vein. The popliteal vein takes the same course as the artery, to the tendon of the adductor magnus, where it becomes femoral. It now ascends to Poupart's ligament, along with the artery, and upon its inner side at the upper part of the thigh, where it becomes the external iliac vein, this unites with the internal iliac vein from the interior of the pelvis, forming the common iliac veins on either side, which at the fourth lumbar vertebra unite together and constitute the *inferior cava*, or

Fig. 9 represents the trunks and principal branches of the venous system. 1 Descending vena cava. 2 Left vena innominata. 3 Right vena innominata. 4 Right subclavian vein. 5 Internal jugular vein. 6 External jugular. 7 Anterior jugular. 8 Inferior vena cava. 9 External iliac vein. 10 Internal iliac. 11 Primitive iliac. 12 Lumbar veins. 13 Right spermatic. 14 Left spermatic vein. 15 Right emulgent vein. 16 Trunk of hepatic veins. 17 Vena azygos. 18 Hemi-azygos. 19 Communicating with left renal vein. 20 Union of hemi-azygos with vena azygos. 21 Superior intercostal vein.

lower trunk of the venous system. This trunk ascends the abdomen on the right of the aorta, receiving in its course all the tributary branches, (except those forming the vena portæ,) to the diaphragm, through which it passes direct to the right auricle of the heart. This vessel returns all the blood of the inferior half of the body.

In the superior portion of the body we commence with the sinuses of the brain, which, emerging at the base of the cranium, become the internal jugulars. These descend the neck, and, with the external jugulars, unite with the subclavian at the base of the neck, and form the vena innominata, which, with the vena azygos coming together upon the right side, constitute the *superior cava*. This vessel then descends to the right auricle, entering at its top.

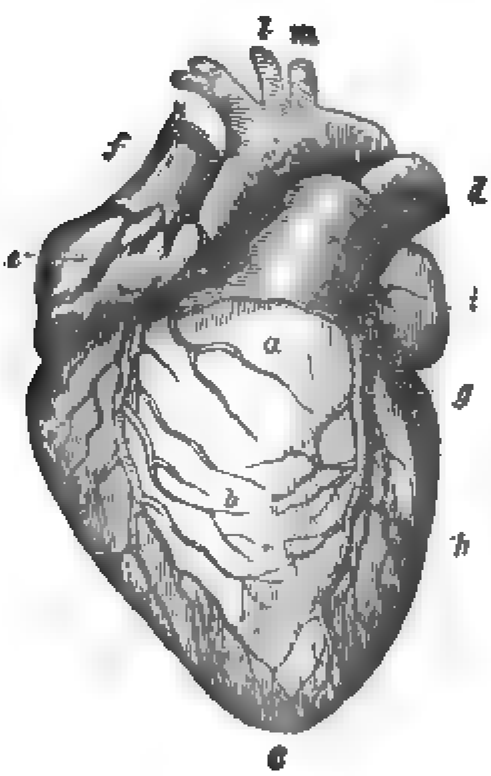
This brings us to the next circulation in order, the *Pulmonary*. This is also called the lesser circulation, in contradistinction to the general, styled the greater or systemic.

It occupies a position intermediate between the venous and arterial trunks of the general circulation, by ending the former and commencing the latter. The trunk of this circulation begins in the upper portion of the right ventricle of the heart, and after a short distance divides into two primary branches, which go to the lungs; these, in turn, again divide and subdivide into countless numbers, which distribute themselves in the form of a net-work over the air cells, which is called the *rete malpighi*. Here it is that the black blood, brought by the pulmonary artery, changes its color to that of red. Here commence the pulmonary veins; and here in breathing animals begins the arterial circulation. The pulmonary veins—four in number, two for each lung—take the blood thus changed, and convey it to the left ventricle of the heart, where ends the lesser or pulmonary, and begins the greater or general circulation. The *Structure* is the same as that of the arteries and veins already described.

There is one remarkable peculiarity in this circulation, deserving notice. It is this: that its arteries carry venous

blood, while its veins carry arterial blood—nothing of the kind being found in any other arteries or veins of the adult body. In the fœtus, however, the umbilical vein carries red blood, and the internal iliac arteries black, but these after birth become obliterated.

Fig. 10.

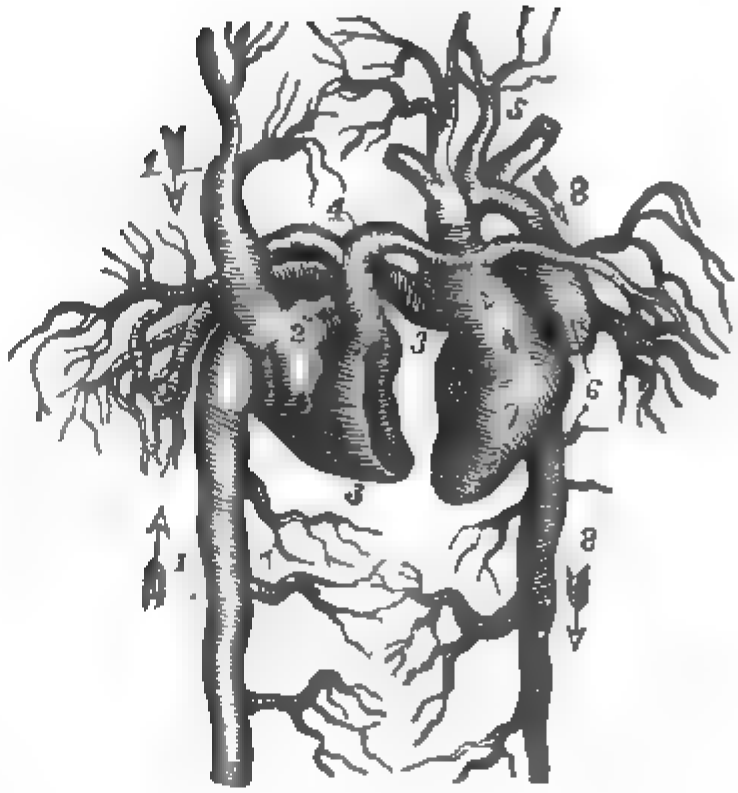


The *Heart* is the centre of the general and pulmonary circulations. It is situated in the middle mediastinum, between the lungs and behind the sternum. Its *form* is that of a cone, the apex being at the junction of the fifth rib and its cartilage on the left, the base above and obliquely to the right. It is a hollow muscle, having four cavities, two auricles, and two ventricles. The auricles are above, and form the base. The ventricles are below, and compose the body and apex. The heart, after birth, is duplicate, and consists of two hearts, right and left. (Fig. 11.)

The right heart, composed of the right auricle and ventricle, contains venous blood; the left, consisting of the left auricle and ventricle, has arterial. The right heart receives the trunks of the venous tree. The left gives off the trunk of the arterial tree. It is enclosed in a strong fibrous capsule, which connects it below with the diaphragm, and above with the great blood vessels arising from its superior portion. Its interior has valves to prevent the blood from retrograding. There are two sets, one to each heart. The right heart has, at the ostium veno-

Fig. 10 represents an anterior view of the heart in a vertical position. *a* Base. *b* Body and right ventricle. *c* Apex. *d* Pulmonary artery. *e* Right auricle. *f* Superior cava. *g* Anterior coronary artery. *h* Left ventricle. *i* Left auricle. *j* Aorta. *k* Arteria innominata. *l* Common carotid. *m* Left subclavian.

Fig. 11.



sum, the tricuspid valve. The left heart, at the ostium arteriosum, has the mitral valve. For further description see organs of circulation.

The heart, arteries, and veins, are the three great and fundamental links in the human adult circulation, each of which is dependent upon the other, and to strike out either would destroy the entire function. Notwithstanding each of these parts has its own proper and especial duty to perform, in carrying on the circulation, still, there are some who limit this action to one or more parts, and deny the rest any share in its performance.

The heart, for instance, was supposed by Harvey, the discoverer of the circulation, and others, to be the sole agent in this function, and that it was accomplished by means of its muscular structure. Hence the various calculations that have been made of the power of the heart's contraction. Borelli estimated it at 180,000 pounds, while Reil only made it from 5 to 8 ounces. These are the two extremes —very wide apart and unsatisfactory, the former being sufficient to rend the body in atoms, the latter too feeble to be thought for a moment sufficient to drive the blood from the heart to every part of the body, and then back again to the heart. Hence Bichat introduces the capillaries to supply the deficient power of the heart. Dr. Barry

Fig. 11 represents the heart double. 1, 1 Superior and inferior cava. 2 Right auricle. 3 Right ventricle. 4 Pulmonary artery. 5 Branches from arch of aorta. 6 Left auricle. 7 Left ventricle. 8, 8 Aorta.

believes the venous circulation to be performed entirely under the influence of the respiration—that during the expansion of the chest a vacuum is produced in the heart, which the blood rushes in to supply—but, unfortunately for this theory, the fœtal circulation goes on when there is no respiration. Others, with more liberality, and no doubt with greater truth, allow each part of the *vascular tissue* its appropriate office, and suppose each to be equally essential in its place to perfect regularity and harmony in this function.

The *Development* of the circulation begins with the veins, as has been traced in the Portal system to the vena cava, at the upper part of which is the heart.

"The heart," says Meckel, "appears at first like a half ring lying loose—the portion first seen is the left ventricle, immediately after, the aorta shows itself, appearing as a considerable dilatation. A little later, the upper extremity of the vein dilates, then contracts before the venous trunk, and thus produces the auricles.

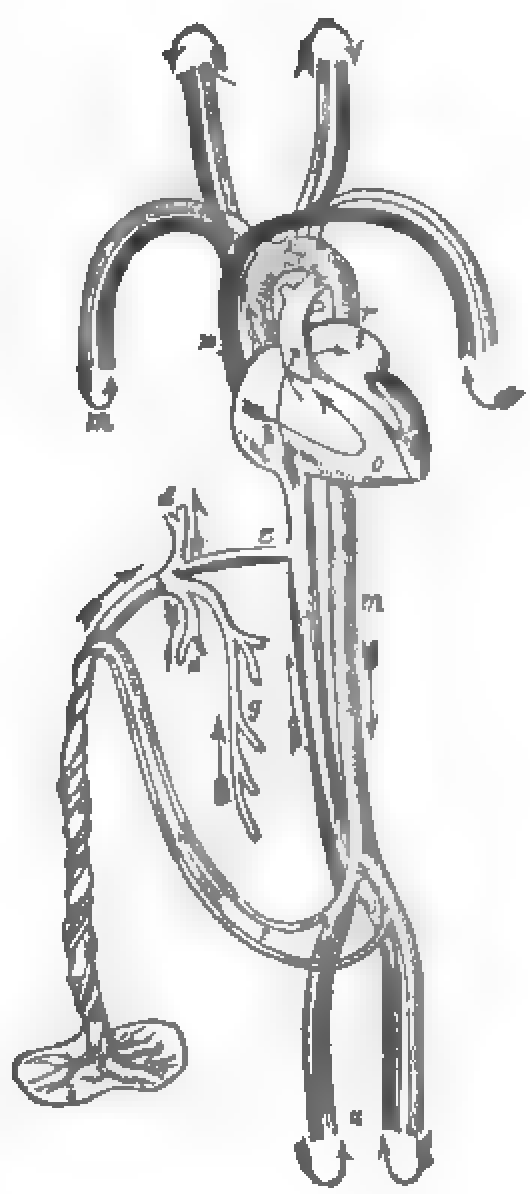
"All the parts which are finally double are still single at this period. The auricle first becomes double; an imperfect septum descends from its circumference and floats in its cavity, so that the two parts communicate by a very broad opening, the inter auricular canal, called afterwards the foramen ovale, and still later, the fossa ovalis.

"The doubling of the ventricle does not take place in the same manner, but is produced by the prolongation of the primitive portion at its upper part. The right ventricle appears first as a small tubercle which gradually extends itself towards the summit of the heart and communicates with the left ventricle. This communication takes place at the upper part of the two ventricles, because at first the left cavity only prolongs itself. Hence the aorta arises at first from both ventricles.

"The pulmonary artery is the last to detach itself so as to constitute a distinct trunk, but it was indicated before along the aorta. In fact the aorta, which at first arises solely from the heart, divides at some distance from this organ into two branches at least, and as the aorta is blended

gradually with the ventricle, the bifurcation is depressed also; and when one of the two branches separates itself entirely from the other, by completing the formation of the opposite portions of their circumference, the pulmonary appears, forming a distinct trunk. But as the cavities of the heart communicate, the pulmonary continues not only at first, but during the whole of fœtal existence, with the aorta of which it constitutes the second root."

FIG. 12.



The *lymphatic circulation* will be noticed under the head of the glandular tissue.

We will conclude the vascular tissue by briefly pointing out the difference between the circulation in the fœtus and the adult.

This difference is seen first (Fig. 12) in the heart. Here, in the fœtus, the auricles communicate by the foramen ovale, which after birth is closed. At the mouth of the inferior cava there is a valve in the fœtus, which disappears in the adult. The pulmonary artery in the fœtus communicates with the aorta by the ductus arteriosus, which in the adult is closed.

2d. The internal iliac arteries of the fœtus carry venous

FIG. 12 represents the fœtal circulation. *a* Umbilical cord. *b* Placenta. *c* Umbilical vein dividing into three branches. *dd* Two of which go to the Liver. *e* The third is the ductus venous, which goes to the inferior cava. *fg* Portal vein. *h* Right auricle. *i* Left auricle. *j* Left ventricle. *k* Arch of aorta. *l m* Show the return of blood by the jugular and subclavian veins. *n* Superior cava. *o* Right ventricle. *p* Pulmonary artery. *q* Ductus arteriosus. *r* Descending aorta. *s* Hypogastric or internal iliacs. *t* External iliacs.

blood to the placenta. These in the adult are closed and become the superior ligaments of the bladder.

3d. The umbilical vein, which carries the blood from the placenta to the fœtus, is in the adult obliterated; that portion between the umbilicus and the liver, becoming the round ligament of the liver; while the remaining portion connecting with the hepatic vein, and thence with the vena cava inferior, is the closed cord of the ductus venosus.

4th. The placenta, which, after birth, is detached from the umbilical cord.

The human placenta is described as consisting of two portions, the one belonging to the fœtus, the other to the uterus of the mother; dense tufts of vascular villi compose the fœtal portion, while the maternal portion is formed of the decidua of the uterus, which receives the fœtal villi—thus formed, it is the medium of nourishment to the fœtus during the period of utero-gestation.

CHAPTER IV.

THE NERVOUS TISSUE.

ANALYSIS.

IMPORTANCE, DIVISIONS ACCORDING TO BICHAT, SITUATION, EXTENT, SYMMETRY, DIVISIONS ACCORDING TO DEVELOPMENT, COMPOSITION, FUNCTIONS, RELATIONS.

THE nervous system, says M. Cuvier, constitutes the animal, and the other systems are provided in order to serve and maintain it. It is regarded as presiding over all the functions of the body, as being the source of all sensation and motion, as regulating the temperature and controlling the different secretions. The importance of this tissue then, cannot be too highly estimated as forming one of the fundamental elements entering into the constitution of the several organs. According to Bichat, it is divided,

1. Into the nervous system of animal life.
2. The nervous system of organic life.

The first division, so called as it belongs especially to animals, connects them with the external world, and is hence classed among the organs of relation; while the second division has its appellation from belonging to the functions of nutrition, which are common to the whole organic world, and constituting organic or vegetative life.

The first division is situated partly within the cavity of the cranium and vertebral canal, and is the central portion of the system; while the remaining part extends to the circumference of the body, and is denominated the radiating or peripheral portion. The second division seems to occupy almost exclusively the trunk, and extends in a chain of ganglia, the whole length of the vertebral column, upon either side. The first division is symmetrical, that is, consists of two equal and similar parts upon either side of the median line of the body; while the second division is in a great measure destitute of this symmetry.

In giving a general outline of the *nervous tissue*, we will adopt that division which is most in accordance with its development, thus connecting its Anatomy with its Physiology. The order will be,

1. The Nerve and Ganglia.
2. The Spinal Marrow.
3. Medulla Oblongata.
4. The Brain.

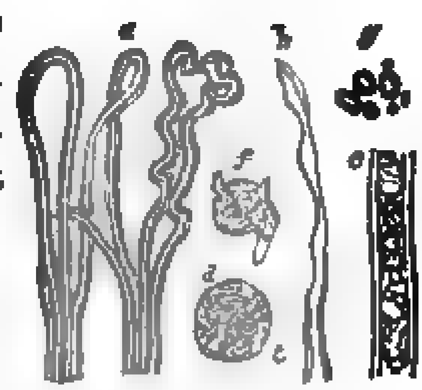
The nervous system in animals low in the scale, is seen in the form of a double cord; a step higher, upon one extremity of this cord are developed knots or ganglia. In the lowest vertebrata, as the fish, five pairs of ganglia are found in succession, upon the anterior extremity of this double cord. In the higher fishes and amphibia, these primitive ganglia have a different disposition. The first two pairs become fused together, forming a single ganglion, or rather are hid by a thin membrane, leaving the three pairs of symmetrical ganglia. This arrangement is traced upwards into the mammalia, where, as in the dog, is seen this single ganglion constituting the cerebellum, and the

three pairs, as before, in succession; and by unveiling this single one, the two primitive pair of Ganglia are revealed, which are now hid by an additional development. These Ganglia, at first disjointed, become connected by transverse fibres, called commissures.

The order, then, of development in the lower amimals seems clearly to be, first, primitive cords, second, Ganglia, and third, commissures uniting these Ganglia and associating their functions.

In the development of the nervous system of man, there are also first seen two filaments or cords, placed side by side longitudinally, and upon these cords at the upper extremity are five pairs of Ganglia. In an after period these two filaments become united and form the spinal cord, except at their superior end, where they continue apart in the crura cerebri. The first pair of Ganglia are developed into the Cerebellum. The second pair, in animals the optic lobes, have in man become the Tubercula Quadrigemina. The third pair form the Optic Thalami, and the fourth the Corpora Striata, the basis of the Hemispheres, while the fifth, very large in the lower animals, are small in man and form the olfactory bulbs. Thus the same order of development in the nervous tissue is established in man as in the lower animals: 1. The primitive fibres or cords. 2. Ganglia upon these cords. 3. Commissures connecting these Ganglia—and finally, development from these Ganglia into the mature and perfect Brain.

FIG. 13.



The Nervous Tissue wherever examined, is seen to be

FIG. 13 represents the minute structure of nerve.

a Loop termination of nerve fibres—one of the loops is convoluted and three are simple. *b* Represents the varicose appearance of a white nerve fibre from the brain, which is made so by pressure or traction. *c* A white nerve fibre enlarged to exhibit its structure, which is seen to be tubular, and containing a substance called neurine. *d* A nerve cell, showing its granular contents. *e* Nucleus and nucleolus. *f* Processes given off from a nerve cell. *g* Nerve granules.

composed of two substances, the one white, the other gray, or cineritious.

Under the microscope the white substance is found to consist of fibres forming perfect cylinders, and varying in diameter, having, according to Solly, an average diameter of 1-2000 to 1-4000 of an inch. They consist of a transparent neurilemma, containing a soft homogeneous substance, which on pressure assumes the knotted form, as seen in *b*, figure 13. This white substance constitutes the whole of the nervous trunks and a large part of the central masses.

Its chemical constitution, by the analysis of Mr. John, is Water 73, Albumen 9.9, White fatty matter 13.9, Red fatty matter 0.9, Osmazome 1, Earthy Phosphates 1.3.

Besides these tubular fibres of the white nervous matter, there are others belonging to the sympathetic nerves, which are found to be only about half the diameter of these fibres. They are of a grayish color and are called organic fibres.

The gray portion of nervous tissue, according to the microscope, consists of spherical globules, containing a nucleus with nucleoli, having a very fine filamentous covering and connected by processes to surrounding globules. These globules are from 1-3000 to 1-1250 of an inch in diameter. This gray matter forms the outer covering of the Hemispheres of the brain, and is there called Cortical or Cineritious. It exists in the interior of the spinal cord, and composes the centre of the Ganglia.

Its chemical constitution, according to the same chemist, is Water 85, Albumen 7.5, White fatty matter 1, Red fatty matter 3.7, Osmazome 1.4, Earthy Phosphates 1.2.

The gray matter is regarded as the source of nervous power, and its collection at various points constitutes the nervous Ganglia, which are regarded as so many independent centres of nervous action; while the white matter and its fibres are considered the conductors of the nervous energy.

The white and gray matter in varying proportions

form the Brain, the analysis of which, according to Vauquelin, is

Albumen,		7.00
Cerebral fat,	Stearine, 4.53; Elaine, 0.70	5.23
Phosphorus,		1.50
Osmazome,		1.12
Acids, Salts, Sulphur,		5.15
Water,		80.00
		100.00

The Nerves.—The primitive fibres already spoken of, collected in bundles and surrounded by a sheath, their neurilemma, constitute a nerve. Nerves are of various kinds, which the dissections and experiments of Sir Charles Bell most clearly demonstrate.

He distinguishes nerves of Motion, nerves of Sensation, and Respiratory nerves. Dr. Hall has since added, what he calls, the Excito-Motor nerves.

The nerves, composed of many filaments, have their roots or origin in a line or streak of nervous matter, as seen in the Brain, which is called a Tract. When these streaks are raised, the term rod or column is applied, as the anterior and posterior rods of the spinal marrow.

These tracts and columns of nervous matter, are considered the sources of endowment to all the nerves originating in them, and the different endowments and peculiar functions of each are owing to the fact of their arising from different nervous tracts.

All nerves arising from the same tract, have the same endowment their whole length, from origin to termination. For example, if we take a filament of a nerve whose office is to convey sensation, that power will belong to it in all its course, whether traced in the foot, leg, spine or brain. When pricked or injured in any way, sensation, and not motion, will be the result, and the perception of the impression will be referred to that part of the skin where the remote extremity of the filament is distributed.

But nerves arising from different tracts may be enclosed in the same bundle, and this may consequently have different endowments. Hence the distinction into simple and compound nerves. Those filaments coming from the same tract are called Funiculi, and form simple nerves. Those coming from different tracts are called Fasciculi, and form the compound nerves. The ninth is a simple, the spinal are compound nerves.

The *course* of the nerve fibres is straight, and without branches, from their origin to their termination.

A *communication* of nerves by means of their funiculi and fasciculi, forms a kind of net work called *Plexus;* the nerves, however, do not run into each other and form an anastomosis after the manner of blood vessels; they simply come together, enter each other's sheaths, run side by side, but are not fused into one.

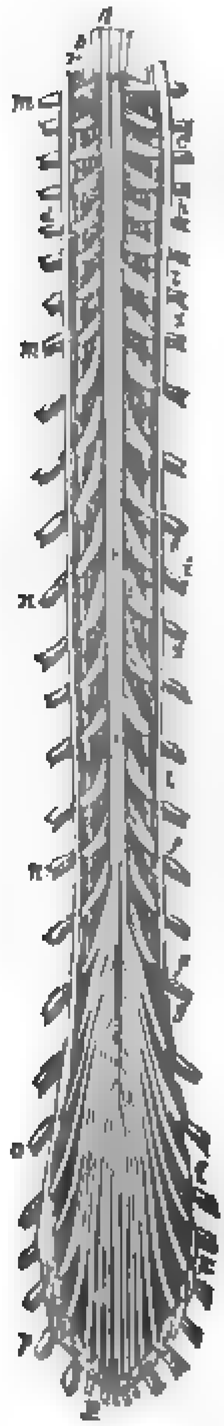
The use of a plexus is two-fold. 1st. It intermixes fibres of fundamentally different endowments, as the spinal accessory and par vagum—the former a motor, the latter a nerve of sensation. 2d. It advantageously distributes nerves of the same endowments, as in the Brachial plexus, where the filaments of five segments of the spinal cord are mixed together, and proceed in this mixed state to the several parts upon which they are distributed. By which arrangement no part can be paralyzed, till all the five segments or centres of action are destroyed—while if each centre sent its nerves singly and alone to any part, when that centre becomes destroyed, the part upon which its nerves are spent will inevitably suffer paralysis.

The nerves *terminate* (Fig. 13) in loops or arches, or more properly speaking, they have no free extremity, but form circles; those, for instance, going from the spinal marrow and brain to the circumference of the body, which conduct the motor power, and called efferent—while the afferent, which begin where the others stop, are continued back again to the place from whence they started—thus completing the circle, and conducting to the central nervous ganglia, sensory impressions.

The *origin* of the nerves brings us to the part next in order, which is the

SPINAL MARROW.

Fig. 14.



The primitive longitudinal filaments, already noticed, coming together and growing, swell into the spinal cord.

This cord, or marrow, occupies the bony vertebral canal, extending from the atlas to the second lumbar vetebra, where it terminates in the cauda-equina. It is surrounded by three membranes—the dura-mater, tunica arachnoidea, and pia mater—the first a fibrous, the second a serous, the third a vascular membrane.

The spinal marrow presents the form of a cylinder having several enlargements in its course, corresponding to the points where the large plexuses are given off as the brachial and lumbar. It is divided in front and behind, by two fissures, anterior and posterior; thus separating it into two equal and lateral halves. These two halves are again divided by a lateral line, which consequently cuts the cord into four parts—two anterior, and two posterior.

These parts receive the name of nervous tracts, rods or columns. Their outer surface is white or medullary, while the inner is gray or cineritious.

There is still another tract placed between the anterior and posterior columns, called by

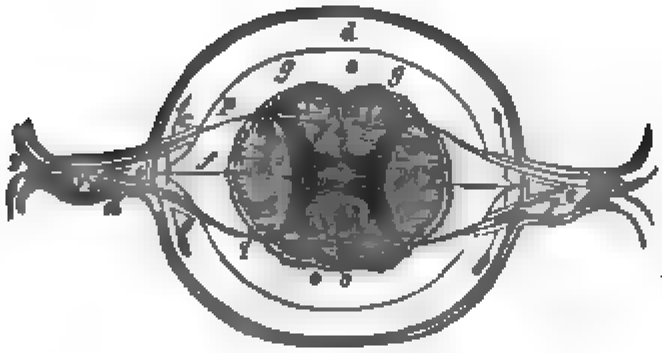
Fig. 14. Anterior view of Spinal Marrow.

a Dots showing corpora pyramidalia. *b* Corpora olivaria. *c* Anterior face of spinal marrow. *d* Anterior roots of cervical nerves. *e* Anterior roots of dorsal nerves. *f* Anterior roots of lumbar nerves. *g* Anterior roots of sacral nerves. *h*, *i*, *j*, *k* Anterior and posterior roots joined to pass out of the dura-mater. *l* Dura-mater of spinal cord. *m*, *n*, *o*, *p* Ganglia on cervical, dorsal lumbar and sacral nerves. *q* Cauda equina. *r* Sub-occipital nerve. *s* Ligamentum denticulatum.

Mr. Bell the respiratory tract, which, with the anterior, forms what is termed antero-lateral.

These different columns give origin to different nerves having different endowments.

FIG. 15.



The anterior give off the nerves of motion, and the posterior those of sensation, the latter distinguished by having a ganglion on their root. And the middle portion supplies the respiratory nerves. There is still another set of nerves described by Mr. M. Hall, as having their centre in, and belonging most especially to the spinal marrow, called the excito-motory, or reflex nerves, having an action entirely independent of volition, and consequently having the power, as proved by experiment, of producing muscular movement when the brain is absent. The fibres, over which the brain exerts its influence in producing voluntary motion, do not stop in the spinal marrow, but, according to Mr. Solly, curve upwards and extend to the brain, thus explaining most satisfactorily why it is that apoplexy, by compressing these cerebral fibres, should produce a loss of voluntary motion and sensation, while those that are free and uncompressed in the spinal cord

FIG. 15. Section of the spinal marrow, with its membranes.

a Dura mater. *b b* Dura mater forming a sheath for each of the roots of a spinal nerve, and afterwards a sheath for the nerve itself. *c c* Sheath around each of the roots of the spinal nerve, by the arachnoid, during its passage through that membrane. The dotted line represents the arachnoid. *d* Space between two layers of arachnoid. *e* Space between arachnoid and pia mater. *f* One of the dentations of the ligamentum-denticulatum. *g g* Pia mater. *h* Anterior median fissure. *i* White commissure connecting the lateral halves of the cord. *j* Grey commissure connecting the two semilunar processes of gray substance. *k* Posterior median fissure. *l l* Antero-lateral columns of spinal cord. *m m* Two lateral columns. *n* Posterior columns. *o o* Posterior median columns. *p* Origin of anterior or motor root of spinal nerve. *q* Origin of posterior or sensitive root. *r* Ganglion on posterior root. *s* Spinal nerve separating into its two primary divisions, anterior and posterior.

should still remain actively alive to all impressions, and produce a variety of corresponding motions without volition or any consciousness whatever.

A step higher and we find these nervous columns of the spinal marrow continued into or surmounted by the *Medulla Oblongata.*

FIG. 16.

FIG. 16. Base of the brain with its nerves.

a Anterior fissure between hemispheres of the Brain. *b* Posterior fissure. *c* Anterior lobes of Cerebrum. *d* Middle lobes. *e* Fissure of Sylvius. *f* Posterior lobes of Cerebrum. *g* Point of Infundibulum. *h* Its body. *i* Corpora Albicantia. *j* Cineritious matter. *k* Crura Cerebri. *l* Pons Varolii. *m* Top of Medulla Oblongata. *n* Posterior prolongation of Pons Varolii. *o* Middle of Cerebellum. *p* Anterior part of Cerebellum. *q* Its Posterior fissure. *r* Superior part of Medulla Spinalis. *s* Middle fissure of Medulla Oblongata. *t* Corpus Pyramidale. *u* Corpus Restiforme. *v* Corpus Olivare. *w* Olfactory Nerve. *x* Its bulb. *y* Its external root. *z* Middle root. *aa* Internal root. *bb* Optic nerve beyond Chiasm. *cc* Optic nerve before the Chiasm. *dd* Motor Occuli, or third pair of nerves. *ee* Fourth pair or pathetic nerves. *ff* Fifth pair or Trigemini nerves. *gg* Sixth pair or Motor Externus. *hh* Facial nerve. *ii* Seventh pair or Auditory, including Facial. *jj kk ll* Eighth pair of nerves—ninth not seen.

The Medulla Oblongata is within the cranium, lying upon the cuneiform process of the occipital bone, has the same arrangement of the white and gray matter as the spinal marrow, and by Mr. Salandier is regarded as the foundation of the central organs. It is composed of six eminences, the corpora pyramidalia, the corpora olivaria, and the corpora restiformia—which are nothing more than the enlargements of the nervous tracts belonging to the spinal marrow.

The *corpora pyramidalia* correspond to the motor tract; the *corpora olivaria* to the respiratory, and the *corpora restiformia* to the sensory. From the *corpora pyramidalia* nervous filaments can be traced through the pons varolii, crura cerebri, thalami, corpora striata, and thence expanding to form part of the cerebrum. Some of these filaments decussate low down, those on the right going to the left side of the brain, and those on the left to the right—by which disposition, paralysis on the opposite side of the body from injury of thé head is explained.

The *corpora olivaria* are by Mr. Solly regarded as chiefly motor, and fibres can be traced from them through the pons to the tubercula quadrigemina, or optic ganglia, and thence along with the fibres of the corpora pyramidalia to the cerebrum, some also going to the cerebellum. Hence the *cerebrum* is by Gall and Spurzheim, who take this as their starting point, said to be formed or developed from the corpora pyamidalia and olivaria—while the remaining tract, the corpus restiforme, is as clearly traced into the cerebellum.

The *corpus restiforme* differs from the others, according to the dissections of Mr. Solly, in having its fibres interlacing instead of parallel.

Most of the cranial nerves arise from the Medulla Oblongata; and from this fundamental point as a centre, the primitive filaments have been traced, radiating to the circumference of the cerebrum and the cerebellum—these are called *diverging fibres*. Another set is traced from the circumference back to the centre—these are the *converging*

fibres. The two sets intersect each other, having spaces termed ventricles, while the converging fibres constitute the Commissures of the Brain.

The Brain, (Fig. 16,) filling the cavity of the Cranium, is, like all other portions of nervous tissue, composed of white and gray matter, but differently arranged, the white occupying the centre, while the gray covers the surface. We however find both kinds, in variable quantity, interspersed throughout the Brain. The Brain is divided into Cerebrum and Cerebellum. The former is again divided into hemispheres, and these subdivided into lobes. The surface of the Cerebrum is thrown into convolutions, which are regarded as the organs of intelligence.

The relation which the Brain, Spinal Marrow, and their nerves, sustain to each other is so intimate as to unite them all in a circle of communication and action. The Brain, forming the central organ of perception, receives the impressions—the Spinal Marrow and nerves of Sensation convey these impressions, while the nerves of Motion carry out the mandates of the Brain to the different muscles of the body—thus forming a circle of conduction, perception, and action.

This tissue has likewise the closest relation with all the organs and functions of the body.

The second great division of the nervous system is that of *organic Life*. It belongs to the trunk, is connected with the organs of nutrition, consists of a great number of Ganglia, whence it is called the Ganglionic system. These Ganglia are found in the neck, chest and abdomen, and send off an infinity of filaments, which, running together and interlacing, constitute the various plexuses, following and intimately surrounding the arteries, in their route to the several organs. This system is also styled the *Sympathetic*, as it connects the different parts of the body together—*Splanchnic*, from its being so largely associated with the various viscera—and, more recently, *Automatic*, from being regarded as self-moving and the original source of nervous power to every other part.

For further details of the sympathetic, turn to the nerves of the Trunk, as connected with the several viscera, particularly those of the abdomen.

CHAPTER V.

THE GLANDULAR TISSUE.

ANALYSIS.

DEFINITION, DIVISION, FORM.

Glands are organs designed to separate from the blood fluids of a peculiar kind, some of which are concerned in important functions, and again re-enter the system, while others are ejected from the body as not only useless, but highly dangerous to be retained.

This definition only applies to those glands having excretory ducts, which in reality are considered as the only true and proper glands, the others being more properly called ganglia.

The glands may be arranged under two divisions,

1. Those having excretory ducts.
2. Those without excretory ducts.

Under the first head we have the salivary glands, the liver, the pancreas, the kidneys, the testicles, the mammæ, the multitude of mucous glands scattered throughout the alimentary tube, and the equally great number belonging to the skin. Under the second division we find the lymphatic glands, the thymus, the thyroid, capsulæ renales, glandulæ Pacchioni, and the pineal gland.

Structure.—The simplest *form* of a gland is the sac or cell follicle, as, for instance, the mucous follicles which consist of a simple depression of mucous membrane, contracted at its orifice into a narrow neck. A second form is that of the tube, also composed of a reflection of the membrane. By the combination of these two forms, says Professor Muller, all the varied glands in the human body, as well as in inferior animals, can be constructed.

The microscope has been most industriously employed in the examination of the minute structure of the glands, and to it are we indebted for most of our knowledge on this subject.

The combination of the two elementary forms constitutes compound glands, of which two varieties are noticed.

1st. Those whose tubes ramify in an arborescent form.

2d. Where they do not branch off, but preserve the same diameter nearly throughout their whole course.

The mammary, salivary and lachrymal glands, with the pancreas and the liver, belong to the first division. This division presents two groups.

FIG. 17.

1. The tubes branch off with some degree of regularity, the first branches sending off others, and these at certain intervals again dividing, till at their terminations, to the naked eye they present the form of acini lobules, or granuli, which, says Muller, are "only aggregates of cells, seated in clusters on the extremities of the most minute secreting canals or tubes, which cells are only visible by the microscope." These minute tubes sometimes branch off into delicate cœca, as seen in the lachrymal glands of the turtle, or into the form of tufts of twigs in other animals. In the second group, the tubes branch off irregularly and do not terminate in cells, but in tufts or twigs. The liver is given as an example, and though it contains acini, they are nevertheless composed of these tufts or twigs.

FIG. 17 represents a portion of the Mammary Gland, and arborescent arrangement of its ducts. *bb cc dd ee* Lactiferous ducts and orifices. *g g g g* Milk cells. *f f f* Excretory ducts from the cells to the larger lactiferous ducts.

The tubes of the second variety, instead of dividing like the branches of a tree, scarcely ramify at all, but proceed on in their course with scarcely any change in their diameter, as in the kidneys and testicles. Here we find the tubes convoluted and of extraordinary length, measuring in the testicle, according to Dr. Munroe, 5208 feet.

The celebrated Ruysch, from his very minute injections, was led to believe that glands consisted entirely of blood vessels, which had a direct communication with the excretory duct. But more recent observations, says Muller, show "that the secreting canals in all glands, form an independent system of tubes—that whether they be convoluted as in the kidney and testes, or ramified in an arborescent form, as in the liver and salivary glands; whether they terminate by twig-like cœca, as in the liver, or in grape-like clusters of cells, as in the salivary glands, pancreas, and mammary gland; their only connection with the blood vessels, in all cases, consists in the latter ramifying and forming a capillary net work on their walls, and in their interstices, and that the finest secreting tubes are always several times larger in diameter than the minute ramifications of the arteries and veins."

The lungs, it is supposed, furnish the best *type* for the whole series of glandular organs.

The general conclusion to which the microscope has led, in reference to the structure of glands, is, that the primitive *cell* is the fundamental and operative part in which all secretion occurs, whether in the simple or complex gland, or in the lengthened secreting tubes, or in the skin or any of the membranes of the body; and that however various the form of the elementary parts, all the glands, without exception, which secrete a fluid, follow the same law of conformation, by developing themselves from the simple *follicle.*

LYMPHATIC GLANDS.

Under this head we will give a general description of the absorbent system, which is as important and interesting as the sanguineous. If the latter carries into the

system the nutrient material for constructing the body, the former conveys out the same material, after it has performed its part in the œconomy, and becomes useless; or rather carries it into the venous blood, to become repurified in the lungs, again to enter the system.

This system is divided into the lymphatic glands and the absorbent vessels.

The lymphatic or absorbent glands, called also conglobate, are very numerous both in the trunk and extremities, and are generally seen in clusters or chains, as in the mesentery and neck. Their color is reddish, inclining to a grayish hue, though the bronchial are black and those of the lesser omentum sometimes yellow. Their consistence is firm and resisting. They are surrounded by a firm capsule of cellular membrane, which sends processes within their substance to unite the different parts, as blood vessels and nerves, with which they are liberally supplied. Their size varies from that of a currant to that of an almond. Their form is round or oval, though some are irregular and lobulated. They are movable in the healthy state, but become firmly fixed by inflammation. Their structure is not fully determined, though they seem to consist essentially of an interlacement of lymphatic vessels, which enter these glands, and after forming a kind of plexus, leave them.

Those entering are called vasa inferentia; those leaving, vasa efferentia.

Cells are spoken of as lying between these two kinds of vessels, into which they open, and containing a peculiar fluid. The absorbent vessels are divided into the lymphatics and lacteals, so called from the color of the fluid they respectively carry, which is transparent in the former and milky in the latter.

Some of these vessels were seen in the mesentery of a goat by Herophilus and Erasistratus, 280 years before the Christian era. Aselius, an Italian anatomist, in 1622 rediscovered or confirmed the original observations of absorbents in the mesentery, made so long before by Herophilus and Erasistratus, and found that these vessels took up the

chyle, but where they took it and what became of it he did not know.

Eustachius, in 1564, discovered in the horse the thoracic duct, which he called vena alba thoracica, the white vein of the chest, not knowing its use. Weslingius, in 1649, found that the chyle vessels or lacteals of Aselius, terminated in the thoracic duct. By the labors of Monro, Hunter, with others, and especially Mascagni, the lymphatic vessels have been demonstrated as extending to almost every part of the body, the only parts in which they have not been seen are the brain, spinal marrow, ball of the eye, and placenta. The lymphatics have been considered as an appendage to the venous system. They resemble the veins in having the same structure, though their coats are more delicate. Like veins, they have numerous valves which give them a knotted appearance. Their currents are in the same direction, and terminate in veins. But they differ from veins in passing through glands, in being less tortuous,

Fig. 18.

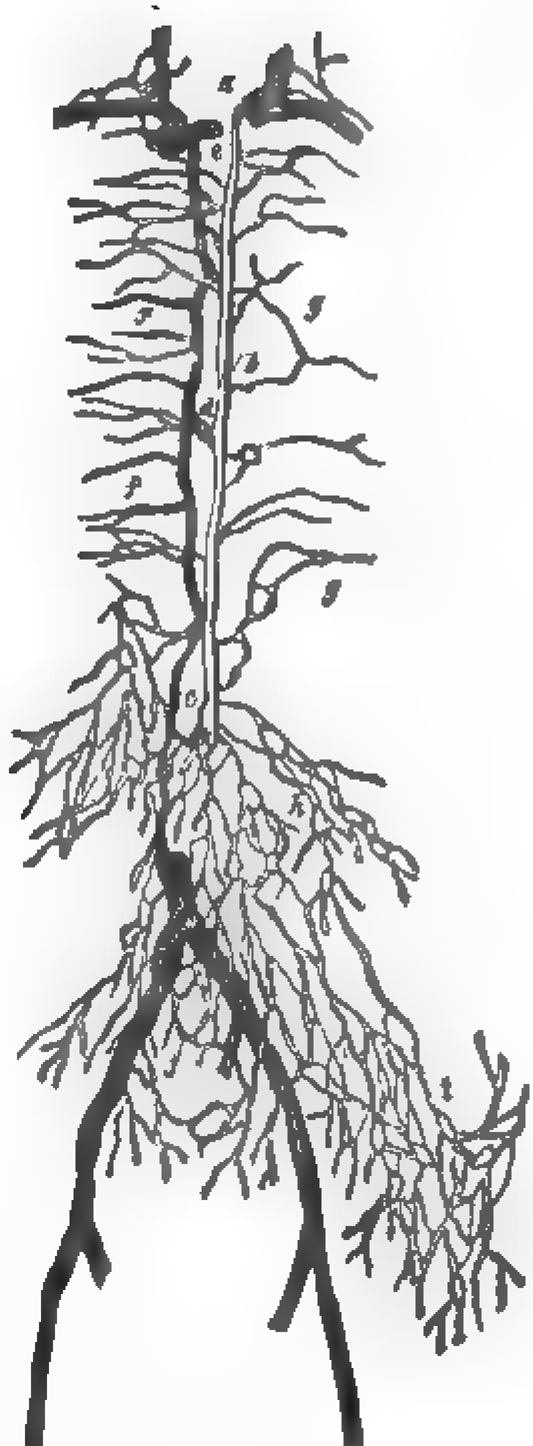


Fig. 18 represents the formation and course of the thoracic duct.

a Termination of thoracic duct. *b* Its separation into two ducts, which again unite. *c* Lower end of duct. *d* Left azygos vein. *e* Right azygos. *f* Intercostal veins entering right azygos. *g h i j* Correspond to numerous lacteals and lymphatics, which go to form the commencement of the thoracic duct.

and in having more numerous and perfect valves. These valves are generally semilunar, and arranged in pairs, though some are circular and do not close the canal entirely.

The origin of the lymphatics is still involved in doubt, whether in the various tissues they commence by open mouths, or are continuous with one set of the arteries, and carry the serous portion of the blood, or whether they begin by a fine net-work of vessels. Let their microscopical origin be what it may, it is well ascertained that the lymphatics come from nearly every portion of the body, while the lacteals spring exclusively from the interior of the intestinal tube, and especially its upper part.

The former carry lymph, the worn-out material of the body; the latter, the lacteals, convey chyle, the fresh material formed by the process of digestion. Both sets of vessels, after passing through the various lymphatic glands, ultimately meet and converge to a point upon the second lumbar vertebræ, behind the aorta, and below the diaphragm, called the *receptaculum chyli*.

This receptacle of the chyle forms the commencement of, and is continuous with the thoracic duct, (Fig. 18,) a tube extending up the thorax between the aorta and vena azygos to the fourth dorsal vertebræ, where it inclines obliquely to the left, behind the œsophagus and aorta, and inside of left subclavian artery, to the seventh cervical vertebra, from which it arches downward and outwards to the junction of the internal jugular and left subclavian veins, at which angle it enters, protected by a pair of valves which prevent regurgitation. This tube receives the lacteals and the lymphatics belonging to the lower extremities, abdomen, left half of the chest, left side of the head and neck, and the left upper extremity. The lymphatics of the right side of the head, right neck, right upper extremity, and right lung, meet, and enter the venous system on the right side by a second tube, at the junction of the right subclavian and internal jugular.

The lymphatics are endowed with the properties of con-

tractility, elasticity, and extensibility, which are no doubt employed in their function of circulating the lymph, but this point is by no means yet satisfactorily settled.

CHAPTER VI.

THE CUTANEOUS TISSUE.

ANALYSIS.

IMPORTANCE, EXTENT, FORM, STRUCTURE, FUNCTIONS AND RELATIONS.

THIS tissue, especially its external portion, has received the names of dermoid, tegumentary, compound villous, or follicular membranes. Its *importance* may be estimated from its early development, vast extent, complexity of structure, variety of function, diversity of relations, and number of diseases.

In the language of M. Beclard, this tissue is the "most universally extended in the animal kingdom; it is the first which is distinct and figured in the embryo; it is on it and by it the rest of the body is formed; and it contains the most essential functions, is often changed by disease, is the part on which all foreign substances produce impressions, and most therapeutic agents are applied."

The *extent* of this element is commensurate with the whole external and internal surface of the body, wherever exposed to the contact of foreign substances. Its *form* has been compared to two canals, the one wide and external, the other narrow and internal, and the two continuous, the intervening space being occupied by the rest of the body. From this peculiarity of form, it consists of two great divisions.

1st. The *skin* and its appendages, forming the outer canal or external surface.

2d. The *mucous membrane*, forming the inner canal or internal surface.

Though these two divisions present striking differences at first sight, yet they are so closely allied in structure, being regarded as essentially the same, that we shall examine both as belonging to the same tissue.

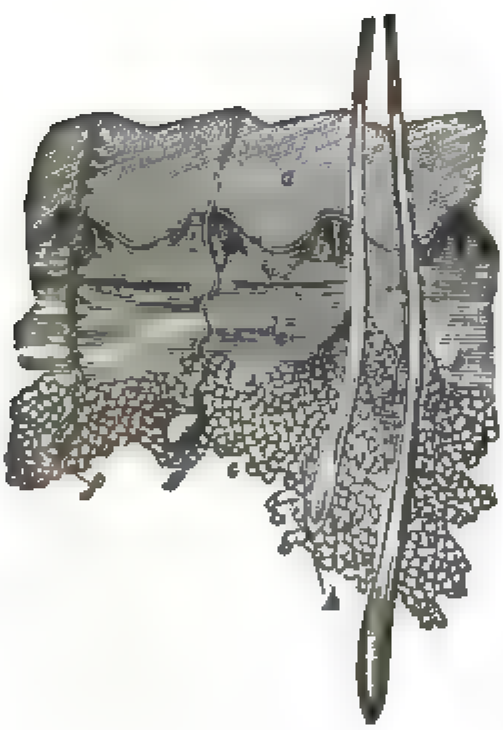
The skin can be traced as gradually sliding into, and becoming insensibly lost in the mucous membrane at all the natural apertures, as the mouth, anus, prepuce, labia, &c., showing the continuity of the two divisions; and their identity is further established by their being convertible the one into the other. For instance, in the axillæ, nates and other parts, where opposing surfaces of the skin come in contact and are not kept clean, the skin will become moist and soft, and present all the appearances of mucous membrane. On the other hand, mucous membrane, as in prolapsus of the rectum and vagina, by being exposed becomes dry, and assumes all the peculiar characters of skin.

SKIN AND ITS APPENDAGES.

The skin, (cutis, δερμα.) as already remarked, covers the whole external surface of the body, and according to the prize essay of Mr. Wheelock, measures in extent 2,500 inches. Its *color* varies from white to black, having all the intermediate shades depending on the different races of mankind, and the difference in climate, age and exposure. Its *density* also varies, being thicker in the black than the white, and much more dense in some parts of the body than others, as in the palm of the hand and sole of the foot. It has two surfaces, the one free and exposed to external bodies, the other adherent to parts beneath by cellular tissue, and in the scalp and neck, closely connected with muscular structure, as over the occipito-frontalis and platyma myoides. The free surface presents a variety of objects of study, as inequalities of elevation and depression, folds and wrinkles, openings or pores, and various grades of softness and moisture, all of which will be more particularly noticed in the account of its structure. The adhering surface, by its loose cellular tissue, generally admits of free motion between the skin and adjacent parts.

The *structure* of the skin consists of three membranes—the cutis vera, reté mucosum, and cuticle.

FIG. 19.



The *cutis-vera*, or true skin, is the innermost layer of the three. It is the chief membrane; is the thickest and strongest, and is regarded as the basis to the other two. According to M. M. Beclard and Bayle, it is composed of cellulo-fibrous structure, in the form of an areolar web, more or less compact—that is, its cellular fibres, more or less interwoven with the fibrous, form a firm, compact membrane, varying in thickness from one-quarter of a line to one line and a half. Its thickness in the trunk is greater behind than before; in the limbs greater externally than internally; it is remarkably dense in the palms of the hands and soles of the feet, and particularly thin in the eye-lids, mammæ, scrotum and penis. We find the cellular and fibrous tissue varying in their relative proportions in different parts, and in accordance with the amount of motion and resistance to pressure; the cellular predominating where freedom of motion is required, as in the axillæ, while the ligamentous or fibrous is most abundant where there is greatest pressure, as in the plantar and palmar regions; and it is in consequence of this combination of the cellular and ligamentous tissue in the cutis-vera, that we find it possessed of the

FIG. 19 represents the structure of the skin. *a* Epiderma, or cuticle. *b* Rete-mucosum. *c* Papillary clumps, quadrilateral in shape, composed of conical papillæ, and seen in the palm of the hand and sole of the foot. *d* Deep layer of derma, the corium. *e* Adipose cells. *f* Sudoriparous gland, with its spiral duct. *g* Sudoriparous gland, with a straighter duct, as seen in the scalp. *h* Two hairs from the scalp, enclosed in their follicles. *i* A pair of sebi-parous glands, opening by short ducts into the follicle of the hair.

properties of flexibility, elasticity, and retractility. It also possesses considerable contractility, as seen in what is called the goose flesh, and in the scrotum, nipples, &c., and which seems to depend upon some reddish fibres, seen immediately beneath the dermoid tissue, having a contractile property and resembling involuntary muscle.

The cutis-vera contains an immense number of blood vessels, nerves and lymphatics, which ramify through its substance and appear upon its surface, and by some these are considered a distinct layer, under the name of the vascular retiform layer and the papillæ, though not generally regarded as a distinct and separate structure. The external surface of the cutis-vera has numerous elevations or projections, called papillæ, which are very distinct on the extremities of the fingers and toes, and on the palms of the hands and soles of the feet. On the fingers these papillæ present the form of arched or concentric rows. These rows are separated by longitudinal and transverse fissures, which it is said give passage to the perspiratory ducts.

The microscope reveals the papillæ to consist of blood vessels and nerves, connected by cellular tissue, and terminating in loops. The nerves are seen without neurilemma, and the blood vessels, according to Beclard, have an erectile disposition. These papillæ, wherever situated, are the seat of sensibility, and those upon the ends of the fingers, called tactile papillæ, are the especial agents of the sense of touch. Though the nerves of the papillæ have been said to terminate in loops, yet it is proper to say that some most respectable anatomists assert that they become so soft and fine that it cannot be determined whether they end in loops, plexuses or soft bulbs. The organic element of the cutis vera is principally gelatin.

The *rete-mucosum* is the next layer in order, and covers the outer or papillary surface of the cutis. It is a very soft substance, and can be raised in a distinct layer, though with difficulty, after maceration. M. Galtier makes it to consist of as many as four separate laminæ, the middle one being the seat of color. The most recent micro-

scopic observations, however, seem to regard the rete-mucosum as forming the internal layer of the cuticle, and being the fresh secreted substance from the cutis vera, which gradually hardens into the cuticle as it approaches the surface. Henle has found it to consist of small oval cells, containing a nucleus which became hardened, flattened, and ultimately changed into the scales of the cuticle.

The coloring matter is also found to be produced by cells, called pigment cells—each containing a nucleus, and many granules. The choroid coat of the eye, it is said, exhibits the pigment cells both distinctly and beautifully. The pigmentum nigrum is sometimes absent in different parts of the body, as in the eyes of Albinos—who are thereby very sensitive to light.

The *Cuticle, Epidermis, or Scarf Skin,* is the outermost or most external layer of the skin. It is easily separated by blisters, maceration, or putrefaction, and often comes off during scarlet fever; on raising it, it is seen to be connected by delicate filaments and hairs to the parts beneath. It consists of one homogeneous layer, destitute of cellular tissue, vessels, and nerves. When separated, it presents the character of the horny tissue—is hard, and varies greatly in thickness in different parts, according to pressure; for example, it is thickest in the palms of the hands and soles of the feet; it exactly adapts itself to all the inequalities, as the papillæ and furrows upon the cutis vera, and from being without nerves and blood vessels, and consequently without sensation and circulation, is admirably suited to protect the very delicate and sensitive surface of the cutis below. At the mouth, anus, and other natural apertures, it is continuous with the epithelium or cuticle of the mucous membrane.

Under the microscope, the cuticle consists of several successions of small, hard, dry laminæ or scales, each of which contains opaque spots of the original nucleus and cells, now flattened into scales, of an irregular form, overlapping each other at their edges, and constantly desquamating or falling off like particles of bran. It is nothing more than

the secreted fluid from the cutis-vera, thrown out, it would seem, like varnish over the whole surface of the body, and then condensing and hardening into the scales just mentioned.

The process of formation is thus seen by the microscope. The capillaries of the cutis-vera throw out lymph, containing numerous cell-germs; these soon enlarge into cells, and closely apply themselves to the surface of the cutis. When this layer is completed a second layer forms beneath, and the first then becomes separated from the true skin, changes its form and consistence, becomes flat and hard, and, by evaporation, dry and firm, and finally falls off in scales; and this succession of changes, from the primitive secreted nucleus of the cell germ, up to the dry flattened desquamating scale, is continually going on.

The cuticle is flexible, elastic, and easily torn. Boiling water extracts some gelatine, renders it white, opaque, and deprives it of elasticity. When dry, its volume is diminished, becomes firmer, slightly yellowish, and resists putrefaction for a long time. Fire causes it to burn like horn and emit a similar odor. The fixed alkalies resolve it into a soapy substance. Nitric acid turns it yellow almost immediately, and thickens, softens and reduces it to a pulp in twenty-four hours.

The skin thus constituted of the cuticle, rete-mucosum, and cutis-vera, has its external surface moistened by two kinds of fluids—the one watery in its nature, called the perspiration—the other unctuous in its character, and known as the sebaceous.

The perspiration, which, when augmented in quantity, becomes the sweat, is furnished by follicles called the sudoriferous or sweat-glands, (Fig. 19;) they are found in all parts of the skin, are of a round form, and consist of a cœca, ending in a spiral tube, the exhalent duct, which passes through the cutis, rete-mucosum, and cuticle, opening on the latter by a minute pore. In the axillæ they are described as large, very distinct, and, by their reddish color, readily distinguished from the fatty grains adjoining them.

The sebaceous or oily fluid comes from sebaceous glands. These, though not so numerous as the perspiratory, are nevertheless abundant in many parts of the skin, as the nose, face, arm-pits, arms, &c.; the palms of the hands and soles of the feet being destitute of them. They present a variety of form, from the simple sac-like follicle to the lobulated gland. In the scalp the lobes are clustered together like a bunch of grapes; and their ducts, which are straight, though sometimes spiral, besides perforating the skin, have one or more of them entering the hair follicle. (Fig. 19.) These ducts are lined by the involuted cuticle. The meibomian glands of the eye-lids, and the ceruminous glands of the ear, are also examples of sebaceous glands.

The sebaceous glands are about the size of millet seed, of a yellow color, and most generally situated, as well as the perspiratory, in the subcutaneous cellular structure, though sometimes imbedded in the dermis itself.

There is another set of glands belonging to the skin, called the odoriferous glands, (glandulæ odoriferæ,) which are very particularly described by Dr. Horner, who seems to have given them more attention than any previous anatomist. He says they are well developed in the negro, and are found in the arm-pit, near the skin, and enveloped in cellular adipose structure. About three hundred of these glands were counted on a space the size of a Spanish dollar; they are described as of a brown color, of varying size, from a line to two lines in length, and having a granular surface, like the mammary and pancreatic glands. Their use is believed to be to furnish the odorous secretions of the body.

The *Functions* of the skin are those of Sensation, Secretion, and Absorption.

Sensation, as already stated, is either *general* or *special*—every part of the skin being supplied with nerves—so, in every part we find common sensibility, or tact, while special sensibility, or sense of touch, is very limited, confined almost exclusively to the tips of the fingers. By this function the health and preservation of the body is particularly

looked after; it stands, as the faithful sentinel, on the outposts of the system, giving immediate warning whenever an enemy is at hand, or an injury is suspected, whether by mechanical or chemical violence or the temperature of the atmosphere. This warning is by the sensation of pain. But this function is also intellectual, as, by the sense of touch, it is the medium of knowledge to the mind.

The *Secretion* of the skin has been stated to be perspiratory and sebaceous. By this function the properties of smoothness, softness, and pliability are imparted to the skin, and a large amount of superfluous matter thrown off, which, if retained, would destroy life.

The amount of exhalation from the skin has been estimated by Sanctorius. It is stated that for thirty years he daily weighed his body, food, and excretions. His estimate was, that out of every eight pounds of nourishment, five passed off by the skin, leaving only three to be carried off by the lungs, kidneys and bowels. M. Seguin made the amount average about three pounds in the twenty-four hours. Twenty or thirty ounces of this exhalation, it is said, cannot accumulate in the system without causing disease; which is no doubt true. The perspiratory function is also one of refrigeration, as by evaporation the body is cooled.

Absorption, though at one period denied to the skin, is now fully established as one of its functions; for by the skin many articles of the materia medica are daily introduced into the system, and produce their effects with nearly the same certainty as when taken by the mouth.

The *Relations* of the skin may be considered as Physical, Chemical, Organic, and Mental.

The principal physical relation of the skin is *atmospheric air*, of a certain temperature and density. If the temperature be too low, the skin will become cold, torpid, and frozen, while the function of sensation will be obscured, benumbed, or entirely lost, and those of secretion and absorption completely checked or destroyed. On the other hand, if the temperature be too high, the violence

of action, will result in the disturbance and destruction of its functions.

The relation of the skin with the density of the atmosphere is equally fixed and important. During an ascent to the top of Mont Blanc, where the air is so much more rare, the cohesive property of the skin gives way for want of pressure; a general relaxation occurs, and the blood, we are told, flows from the whole surface of the body. Too great density, on the other hand, would be equally destructive.

In regard to the *Chemical* relations of the skin, it is well known that if chemical agents be not applied in their due and proper proportion, they are violently destructive, at once disorganizing the skin, breaking up its whole texture, and, consequently, destroying all its functions.

The skin, being an organ, and forming part of the body, becomes necessarily connected with, and more or less dependent on, every other part or organ; and hence it has *organic relations*. The principal of these are with the mucous membrane and kidneys. When the functions of these organs are increased, those of the skin are diminished, and vice versa.

The *Mental Relations* of the skin, or those it has with the brain and nervous system, are equally striking. Every one has seen fear and grief contract the skin, and render it pale, cold, bloodless, benumbed, deprived both of sensation and secretion. Anger and joy, on the contrary, dilate the skin, fill it with fluids, increase its color, excite all its functions, and, if in excess, will as certainly injure and derange them.

Now these several relations constitute so many fixed and definite laws for the regulation of the skin's functions—obedience to which has the high reward of health and life; disobedience, the penalty of disease and death. The penalty is inflicted in a variety of ways, as in *vices* of conformation, congenital and acquired, accidental productions, as fistulas, abscesses, morbid secretions of the sebaceous follicles, having names according to the kind and consistency

of the fluid; a variety of tumors of varied size and character, as the steotoma, atheroma, meliceris, &c., or a fatty, a pulpy, and a honey-like tumor; and, finally, inflammation in all its various forms.

APPENDAGES OF THE SKIN.

The appendages of the skin consist of the *hairs* and *nails*, which are modifications of the cuticle.

The hairs (Fig. 19) present differences, according to their situation, in length, fineness, delicacy, quantity, size, and color. They differ according to races, being long, fine, thick, and often curled, in the Caucasian and Malay, fine and thin in the American, short and coarse in the Mongolian, and crisped and woolly in the Ethiopian. They vary also with age and sex, being finer in the young than in the old, and in the female than in the male.

Each hair is composed of a bulb and stem. The bulb is simply a reflection of the skin, termed the follicle, containing a conical pulpy substance called the papilla. The follicle is ovoid in shape, and lined by the involuted cuticle; it is embedded in the subcutaneous, adipose, and cellular structure, and is highly vascular and sensitive. The papilla is the part of the bulb generating the hair; from its vessels, lymph is poured out containing cell germs; these grow into cells with nuclei, which elongate and become condensed into scales, overlapping each other, and forming the cortex or outer surface of the hair.

The hair lengthens by fresh successive additions from the papilla, one beneath the other, constantly repeated, as long as it continues to grow.

The interior of the hair, called the medulla, has its cells less condensed than the outer, and, on a transverse section, gives the appearance of a cell-tube.

Hair can be split, and of itself separates into filaments. Pigment granules are found in the cells of the bulb, on which the color depends; and into the follicle the ducts of one or more of the sebaceous glands open and discharge

their fluids, which, it is said, lubricate the hair throughout its whole course. (See Fig. 19.)

The formative force is very great in hair. It is quickly replaced when cut or destroyed, provided the bulb and papilla remain uninjured. Hair is entirely destitute of vitality, except at its root or bulb, where it is both vascular and sensitive, as seen in the disease called *plica-polonica*.

The motions of the hair are referred to the action of subcutaneous muscles. This is very evident in the large hairs or prickles of the porcupine, and the feathers of the tail of the peafowl, where each is supplied with a distinct muscle for its elevation.

Hair, like the cuticle, resists putrefaction for a long time. Boiling resolves it into gelatin and coagulated albumen. According to Vauquelin, hair is composed of an animal matter which forms the base—a small quantity of a white concrete oil, a blackish oil, iron, oxide of manganese, carbonate of lime, silex, and sulphur.

The Nails are the horny scales which cover the last phalanx of the fingers and toes. Each nail consists of a root, body, and free extremity. The root and borders are confined in a fold of the cutis, named the nail-follicle; the body rests upon the surface of the cutis, called the matrix, which is very vascular, and appears red; while the white portion, just at the root, is styled the lunula. The nail grows in a manner similar to the cuticle.

The nail follicle and matrix contain papillæ, that secrete the fluid or lymph in which are found cell-germs. These, like those of the hair, become compressed, dry, flattened and hardened into nail: those at the root elongating and adding to the length; those at the borders forming the breadth; while those in the matrix, or centre, increase the thickness.

The nails protect and form a firm support to the tactile papillæ or organs of touch. They are also instruments of prehension.

THE MUCOUS MEMBRANE.

This constitutes the second division of the Cutaneous System. It lines the whole interior of the surface of the body, having communication with the exterior world. It is consequently coextensive with the digestive, pulmonary, urinary, and genital organs. It is continuous, as before stated, with the skin. Its *color* varies from a pale rose to a beautiful red. Its *density* also varies, being thinner in the urethra and genital organs than in the intestines. Its *tenacity* is so slight, it tears easily in the attempt to raise it.

Like the skin, it has two surfaces, the one free, the other adherent. The free surface presents valvulæ, folds and wrinkles, cavities or depressions, and papillary and villous projections. The adhering surface is covered by a fibro-cellular tissue, which gives the mucous membrane its solidity. It has two principal divisions.

1st. The gastro-pulmonary.

2d. The genito urinary.

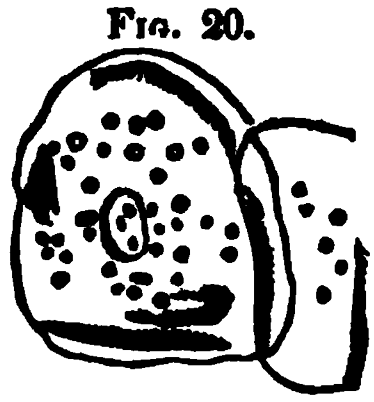
The first division lines the mouth, where it is continuous with the skin of the lips, and successively the pharynx, œsophagus, stomach, and intestines, to the anus, where it again runs into the skin. In this route it sends off numerous prolongations to all the excretory ducts of the glands, communicating with the alimentary canal, as the salivary glands, tonsils, liver and pancreas. It extends to the nose under the name of pituitary membrane, lining it and the different sinuses. Through the nasal and lachrymal duct it reaches the eye, covering the interior of the eyelids, and the globe of the eye. From the back part of the mouth we follow it in one direction through the Eustachian tube, into the cavity of the tympanum, and the mastoid cells, by another route we trace it into the larynx trachea, bronchi, and all their ramifications in the lungs.

The 2d division or genito urinary, beginning at the glans penis, is found lining the urethra, bladder, ureters, infundibulum, and even calyces of kidneys, while in the female it also covers the labia, clitoris, and vagina.

The mucous membrane presents different appearances in the different organs it traverses. It is disposed in longitudinal folds, is thick and loosely attached to the muscular coat in the œsophagus. It presents the form of plaits or rugæ in the stomach, and of valvulæ conniventes in the upper intestines.

The *structure* of the mucous membrane is very analogous to that of the skin, and like it, consists of three membranes, an epithelium, a proper mucous and a fibrous coat. The epithelium corresponds with the cuticle, and consists of nuclei, vesicles, and scales. It has, until very recently, been considered as extending inwardly only to the cardiac orifice of the stomach, but by the microscope it now seems to be satisfactorily established as covering the whole extent of the mucous surface wherever found.

FIG. 20.



The epithelium presents a variety of forms in different situations. In the mouth (Fig. 20) it assumes the shape of laminæ, the nuclei or cytoblasts forming the deepest layer, then upon these are the cells, and upon these again the topmost layer of polygonal scales, which become thin and flattened, and constitute the highest stage of development from the cell germ or nucleus. The nuclei, cells and scales are connected by a glutinous substance, in which are found opaque granules. The scales are constantly exfoliating, and give place to the deeper layer, which in their turn give way to others, and so in perpetual succession, there is a perpetual waste and supply.

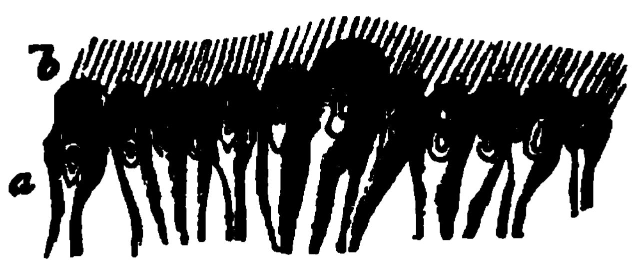
In the stomach and intestines, the epithelium (Fig. 21) has the columnar or cylindrical shape, the apices of the columns resting on the papillary coat, while the bases, by their approximation, form the free surface. Each column has its nuclei, cells and scales, and is produced in the same way as the laminated epithelium, and also undergoing the constant waste and supply.

FIG. 20. Epithelium scales from inside of the mouth.

FIG. 21.

The columnar form of epithelium is also found in all the glandular ducts, whose bases are often surmounted with ciliæ, (Fig. 22,) whose motions are directed towards the outlets of the canals they line.

FIG. 22.



The second coat, the proper mucous, called also the papillary or basement membrane, resembles the papillary layer of the skin, and is a membrane apparently without texture. Its surface presents different aspects at different points.

In the stomach it forms cells or alveoli, into which the follicles open. In the intestines it presents numerous projecting points, having a velvety appearance and called *villi*, while in the large intestines it again, as in the stomach, assumes the shape of cells. This coat is exceedingly soft and spongy, easily destroyed either by mechanical violence or the action of acids, which reduces it to a pulpy state.

The fibrous layer, called also the *sub-mucous* and *nervous*, forms the third layer of mucous membrane. It corresponds to the corium of the skin, in giving support and strength to the mucous layer, and contains numerous capillary vessels, nerves and absorbents.

It has just been stated that the mucous membrane has upon its papillary surface numerous conical projections,

FIG. 21 represents cylinders of the Intestinal Epithelium.

1 Cylinders from cardiac region of the human stomach. 2 Cylinders from jejunum. 3 Cylinders seen from their free extremity. 4 Cylinders as seen in a transverse section of a villous.

FIG. 22, Ciliated Epithelium. *b* Cilia upon the top of *a* epithelium.

called villi from their velvety appearance, or their resemblance to the down of an unripe peach.

Each villus consists of blood vessels, nerves and absorbents bound together by cellular tissue, and not only covered by epithelium, but also, it is said, by an additional fine membrane. These villi give origin to the lacteals by fine branches, which, it is now found, do not have open orifices upon their surface as formerly believed, but between the capillary vessels at the extremity of each villus, while chylous absorption is going on, are seen cells containing an opalescent fluid. These cells disappear almost entirely, it is said, when the chyle has left the intestine; the lacteals empty themselves, and the villi become flaccid.

These cells are regarded as the special agents for selecting the nutrient matter and handing it over to the lacteals; they have a short life, and are constantly being renewed. Another element of mucous membrane is found in the *follicles* and *glands* scattered throughout its whole extent.

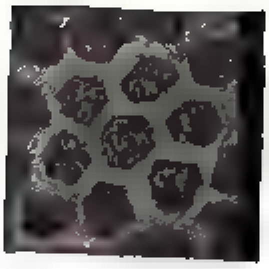
The simple follicles of Leiberkuhn exist in immense numbers every where upon the mucous surface. They consist simply of depressions of the mucous surface, forming small pouches, whose orifices are not visible to the naked eye, but which are found to have eight or ten times the diameter of the red globules of blood.

Professor Horner has estimated the number of these follicles to be about 25,000 to the square inch, and between forty and fifty millions to the whole alimentary canal. Their use is to supply the principal part of the mucous fluid. The glands are simply compound cryptæ or follicles, having different forms and names, in different parts of the mucous membrane.

At the mouth of the Eustachian tube, the simple follicles are collected in a body of somewhat oval form and almond size, called the tonsil. In the œsophagus these follicles are situated in the sub-mucous tissue, and lobulated, communicating with the surface by a long excretory duct.

In the stomach the glands are seen in the shape of long tubes, situated perpendicularly, side by side, and, at their

FIG. 23.



terminations, dilated into small pouches, having a clustered appearance. These are supposed to secrete the gastric fluid.

In the duodenum is another set of glands called, after their discoverer, Brunner's Glands. (Fig. 24.)

FIG. 24.

They are small, granular, and flattened, and compared to the pancreas and salivary glands; each granule consisting of minute lobules or cells, all of which open upon the surface by a common duct. In the lower part of the ileum are the glandulæ agminatæ, or Peyer's glands. (Fig. 25.) They are found most abundant about the junction of the ileum with the colon, and opposite the attachment of the mesentery. They are collected in numerous small circular patches, surrounded by the simple follicles. Each is simply a closed sac, having no excretory duct, as far as observation has gone, and, when ruptured, is found to contain mucus and small cells. Their use is not known. It is thought by some that ulceration of Peyer's glands constitutes the essential

FIG. 25.

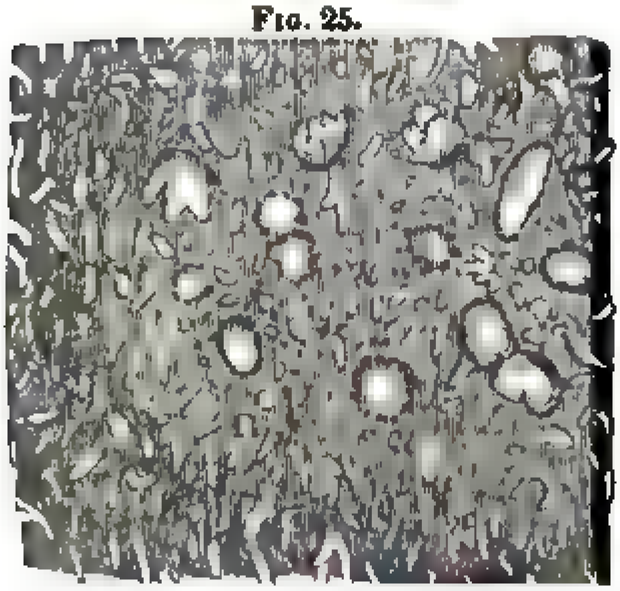


FIG. 23 represents a portion of the mucous membrane of the stomach, showing the pits upon its surface, and where the tubes from the gastric glands enter.

FIG. 24 represents a portion of one of Brunner's glands from the human duodenum—magnified 65 diameters.

FIG. 25 represents a portion of one of the patches of Peyer's glands at the termination of the ileum.

element in typhoid fever, while others regard such lesion simply a result of the latter.

There is another set of glands belonging to the mucous membrane, called the Glandulæ Solitariæ, or Solitary Glands. These are of two kinds—those having excretory ducts, or openings, and those without. The first are found in the large intestine, being most abundant in the cœcum. The second are seen in the small intestine, in the form of small circular patches, surrounded by a wreath of simple follicles, and, when opened, present a small, saccular, flattened cavity, holding mucus.

Dr. Horner, who has paid much attention to the investigation of the minute anatomy of the mucous membrane, seems to think, from his observations during the cholera, and minute injections of this membrane, that it "consists almost entirely of a cribriform intertexture of veins;" and, in death, these veins being empty, are soft and spongy, and give the velvety appearance of ordinary descriptions. The arteries are described as few in number, and situated beneath the venous intertexture, and much smaller than the corresponding veins. The meshes in this venous intertexture are very minute, and are considered as the simple follicles of Lieberkuhn, resting upon the arterio-venous layer and cellular structure below as their basis. Dr. Horner is led to believe, from this anatomical arrangement of the mucous membrane, that the functions of these follicles are rather for *absorption* than, as generally supposed, for secretion. As the Fallopian tube, by a vascular turgescence, erects itself and grasps the ovum, in like manner, says the doctor, "as these intestinal follicles are formed in the midst of veins, their orifices only become erect and patulous by the distension of those veins, and cannot be well seen by the eye alone, unless an injection has fully succeeded. But the erection of these veins, during digestion, puts the follicles in a similar condition; there is, therefore, some ground of inference that the act of the Fallopian tube in conveying a germ, and of a follicle in conveying into the thickness of an intestine congenial matter, may be analogous."

Again, this same anatomist universally found the surfaces of the villi polished, and not presenting any foramina, while many of the follicles were found passing obliquely into their bases. In a word, the gastro-enteric follicles, situated in the venous intertexture above described, and considered as identical with its meshes, are regarded as the absorbing agents of the chyle, which conduct it into the lacteals.

The *functions* of the mucous membrane are, like those of the skin, sensation, secretion, and absorption. Besides the common sensation of the whole membrane, and the special sense of taste as belonging to it, and seated in the tongue, the feelings or appetites of hunger and thirst are also referred to this membrane. Its secretions are those of serum and mucus, &c., and it absorbs, as already stated, the chyle with other matters.

The *relations* of the mucous membrane are as fixed as those of the skin, and are, chiefly the physical, chemical, and organic.

The principal physical relations are those it has with *food* and *water*.

It is well known that our food and drink enter the system mainly through this structure, and if we attempt, in the healthy state of this membrane, to substitute any thing else in place of the natural stimuli, there will certainly be more or less lesion and disturbance of its functions. For instance, if we swallow poison, in place of food, there is the greatest danger not only of disturbance, but of complete destruction to both structure and function, by the most rapidly violent and destructive inflammation. And this example further shows the chemical relations of this membrane to be equally fixed, and necessary to be observed, for the preservation of its integrity.

Its *organic* relations are most important, both in health and disease, as it sympathizes with, and is the channel of intercourse to every other part and organ of the body.

Now, these several *relations*, as in the case of the skin, constitute so many fixed laws—obedience to which, we

equally find, has the reward of health and life, and disobedience the penalty of disease and death. The penalties refer to the pathological state of this membrane, the principal of which consist in—

Malformations, congenital or acquired, as seen in obliteration of the rectum.

Displacements, as in prolapsus of the vagina.

Stricture, as in the urethra.

Tumor, as polypi of the nose and uterus.

Vegetations.

New Formations, as cartilage, bone, hair, &c.

Discharges, as serum, mucus, blood.

Inflammation, with all its terminations in suppuration, ulceration, and gangrene.

The appendages of the mucous membrane are the Teeth; which see in another part of the work.

CHAPTER VII.

THE MUSCULAR TISSUE.

ANALYSIS.

DEFINITION, IMPORTANCE, DIVISION, FORM, COLOR, SIZE, CONSISTENCE, COURSE, NUMBER, ATTACHMENTS, NOMENCLATURE, STRUCTURE, FUNCTIONS, DEVELOPMENT.

Muscle (from μυων, a muscle, or μυς, a mouse,) is the active organ of motion in the different parts of the body. In familiar language, it is called the flesh, and, by its property of contraction, is connected with many of the most important functions. The importance of this tissue may be estimated, when we consider that the functions of digestion, respiration, circulation, locomotion, speech, and expression, are all dependent upon it. Muscles, as we shall presently see, consist of bundles, mostly of reddish fibres, of variable size and strength, and have a head, body, and tail, or, in more anatomical language, an origin, course,

and insertion. The muscles, collectively, form the muscular system. They have been arranged under two grand divisions.

1st. The *Voluntary*, or all those subject to the control of the will. 2d. The *Involuntary*, or those over which the will has no influence. A third division is made, called the Mixed class of Muscles, which is a compound of the other two, over which the will has only partial control, as seen in most of the Sphincters.

The first class are by far the most numerous, and situated chiefly upon the face and extremities—composing the greater bulk of the organs of relation. The second class belong to the organs of nutrition, comprising the stomach, intestines, heart, &c. Muscles are either arranged in pairs or are symmetrical. The first are found upon either side of the median line of the body, perfectly distinct, wide apart, and each exactly alike, as upon the limbs; or they may approach so close along the middle line as to touch óne another, but still preserve their perfect distinctness of separation. The symmetrical muscles are situated precisely upon the median line, and consist in two equal and similar halves.

Muscles, according to their form, are distinguished into the *long*, the *flat* or *wide*, and the *short*. The long muscles are generally placed upon the limbs, to the beauty and conformation of which they very much contribute. The wide are mostly situated upon the parietes of cavities, as those of the chest and abdomen, and "serve to protect the internal organs, aid their functions, and move the body or the limbs, as the one or the other is the fixed point." The wide muscles, generally, are not very thick—in some places resembling a thin membrane, as the broad muscle of the neck, so conspicuous in the horse, which that animal uses as a fly-brusher. The short muscles are commonly met with in parts where there is a limited extent of motion and great power required, as in the movements of the lower jaw and the thumb. The *situation* of muscles is either superficial or deep. The superfi-

cial are immediately beneath the skin, and arranged side by side, while the deep surround the bones and occupy the interior of cavities.

The *color* of muscles is red, varying in intensity in different muscles, and in different individuals. The red color, however, only applies to the voluntary muscles; for the involuntary, as those of the intestinal tube, bladder, &c., are exceedingly pale, and, in some of the lower animals, the whole muscular system is completely colorless. The color is thought to be independent of the blood circulating in their vessels; and the bright red of those muscles subject to the control of the will, is an invariable evidence of both vigor and activity.

The *consistence* of muscles varies in different individuals, and in the same individual at different times, according as the system is healthy or diseased. In some they are soft and easily torn; in others they are not only firm and resisting, but for some time after death remain rigid. Their *size* also varies, from the extremely delicate muscles of the face, to the powerful *gluteus maximus* of the hip. The *course* or *direction* of muscles is essential to a correct knowledge of their several actions, and of the proper method of reducing dislocations. Every muscle has an axis or middle line, in which its fibres centre or take effect, and should, says M. Cruveilhier, be studied with special reference to the axis of the limb, or lever of which they are the moving power.

The *number* of muscles varies in different animals, and in proportion to the variety, and the extent of motion, each has to perform. The number in man is not agreed upon by anatomists. Prof. Chausier makes 368, Paxton 527, while others make 450; 400 is considered a fair average number. The cause of this disagreement is owing to the fact that some muscles are divided into two or more, while others think they should be considered but as one.

The names given to muscles, are derived from a variety of circumstances, as their *uses*, *attachment*, *direction*, *figure*, *composition*, *size*, &c. Examples of names from *uses* may

be found in the flexors, extensors, and rotators of the limbs; from *attachment* in the muscles, connected with the styloid process of the temporal bone, the hyoid bone, the tongue, and pharynx, and named the stylo-hyoideus, stylo-glossus, and stylo-pharyngeus; from *direction* in the straight muscles of the thigh, the oblique of the neck, and transverse of the abdomen and perineum; from *figure* in the rhomboidei or four-sided muscles of the back, and the scaleni or unequal-sided triangular muscles of the neck; from composition in the biceps, triceps, perforans, &c., as they are composed of two heads, three heads, or are perforated.

The *attachment* of muscles is various. They are attached to the skin, as in the platysma myoides of the neck, to other muscles as in the angles of the mouth, to cartilages as in the chest and larynx, to aponeuroses, to tendons, and through these to the periosteum and bones. The attachment of muscles to the most fixed point is called their origin, while that to the most movable is regarded as their insertion.

The *structure* of muscles consists of bundles of fibres called fasciculi, enclosed in a cellular membrane or sheath. Each fasciculus is composed of still smaller bundles, and these again of single and more minute filaments; and here the microscope is brought in to determine what is called the *ultimate fibre*. (Fig. 26.)

This ultimate fibre is found to consist of a number of still smaller fibres called the *ultimate fibrils*, which are enclosed in a very delicate sheath termed the myolemma or sarco-lemma.

FIG. 26.

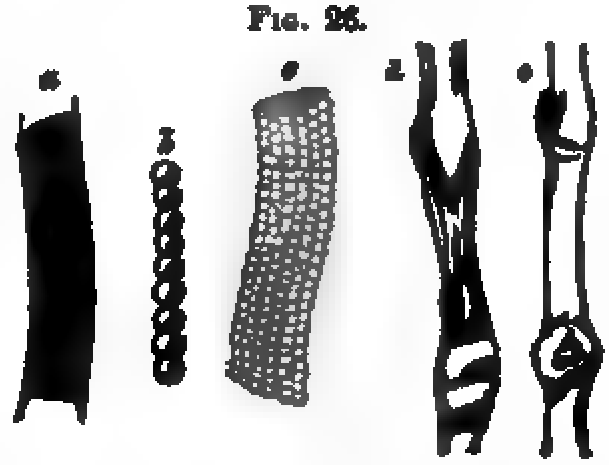


FIG. 26 represents the Muscular Fibre of animal and organic life—a muscular fibre of animal life enclosed in its sheath, the myolemma, and showing the transverse striæ; *b* Ultimate fibril of the same; *c* A more highly magnified view of Fig. *a*; *d* Muscular fibre of organic life, from the urinary bladder, magnified 600 diameters; *e* Muscular fibre of organic life, from the stomach.

This sheath is considered quite distinct from the cellular tissue surrounding a fasciculus of fibres, and is perfectly transparent.

The microscope reveals two kinds of ultimate fibres, one belonging to the muscular system of animal life, or voluntary muscles, the other to that of organic life or the involuntary class. The fibre of animal life is known by being marked with transverse striæ, by having the fibrillæ beaded or knotted, and presenting a varicose appearance. The fibre of organic life has no transverse striæ, and is much smaller than the fibre of animal life. It presents swellings at different points, and this is considered as one of its most prominent characteristics. The form of the ultimate fibre, according to Mr. Bowman, is polygonal.

When the fibrils are separately examined, they are found to present spaces of alternate dark and light color. The *size* of these ultimate fibrils, according to Wagner, is nearly the same in all the vertebrata, from the 1-8856 to 1-11076 of an inch in diameter. The diameter of the primitive fasciculi is stated to be very variable in the different classes and genera, and even in the same animal and same muscle.

The size is greater in the male than in the female, the average diameter, as given by Mr. Bowman, is about 1-400. The microscopic observations of Mr. Bowman also show that there exist in the substance of the ultimate fibre, small discs, either circular or oval, frequently concave on one or both surfaces, and having, near the centre, one, two, or three minute granules or dots. These are found to be connected with, and distributed in nearly equal numbers between, the fibrils; and these granules or corpuscles are regarded as the nuclei, which being developed into the nucleated cell, constitute the origin whence the muscular fibre is formed. The corpuscles can be seen by treating muscle with some of the milder acids, as the citric. Blood vessels and nerves enter abundantly into the structure of muscles. Muscles possess the vital property of contractility, by which they can contract and shorten themselves, and which, as already stated, they take part in a great variety

of functions, and form the especial and active agent in locomotion.

Fibrin is the chemical element constituting the great mass of muscle, and peculiarly adapted to contraction. The chemical composition of muscle is thus given by Berzelius:

Water,	77.17	Alcohol. ext. with salts,	1.80
Fibrin,	15.80	Watery,	1.05
Albumen with coloring matter,	2.20	Phosphate of lime with albumen,	0.08

The different varieties of muscular contraction are those of force or intensity, duration, velocity, and extent; and examples of each variety may be seen in the several muscles of the human body. The most rapid movements, according to Haller, are to be found in the muscles of the voice, since the pronunciation of a single letter can be executed in the 1-3000 part of a minute.

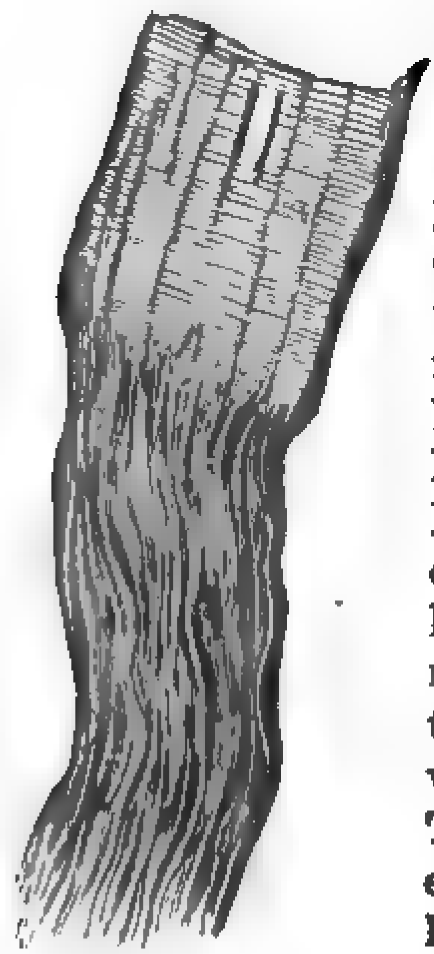
From experiments on the bodies of executed criminals, Mr. Nysten found that the muscles lost their contractility in the following order—first, the left ventricle of the heart, next the intestinal canal in 45 or 55 minutes, the urinary bladder in nearly the same time; in one hour the right ventricle, in one hour and a half the œsophagus, the voluntary muscles a little later, and the last of all, the auricles of the heart, particularly the right, which, it is said, under the influence of galvanism, contracted 16½ hours after death. Muscles also have sensibility, and are further endowed with an especial sense, called the *muscular sense*, by which the precise state of the muscles is made known.

The *development* of the muscular system takes place from the germinal membrane, which is made to consist of three layers, an external or serous, an internal or mucous, and a middle or vascular. The voluntary muscles or those of animal life, found in the trunk and limbs, are developed from the serous layer, while the involuntary or those of organic life, comprising the intestines, bladder and internal organs of generation, are developed from the mucous.

The vascular layer develops the heart, which, though involuntary, is found to contain the transverse striæ of the muscles of animal life.

Tendons.—Tendons form the extremities of muscles, as a general rule, though we sometimes find them, as in digastric muscles, occupying the centre.

FIG. 27.



They are easily distinguished by their beautifully white and shining appearance, and though seemingly continuous with the muscular fibre, and at one time considered as such, yet by maceration and boiling they can be separated. The structure of tendon is cellular, condensed, and modified into the funicular or cord-like, and the membraniform shape. Its chemical element is gelatin. Its fibres run longitudinally, being connected by lateral fibrils, and adhering with the greatest tenacity to muscle. They have so little extensibility, that it is believed they will break sooner than stretch. They have no contractility, nor elasticity. Their sensibility in the healthy state is obscure, while in the diseased it becomes very evident. In health, tendons have no red blood circulating in them, while in inflammation the red globules become very manifest. No nerves can be traced passing into this tissue.

FIG. 27 represents the attachment of tendon to muscular fibre.

CHAPTER VIII.

THE FIBROUS TISSUE.

ANALYSIS.

SYNONYMES, DEFINITION, DIVISION, FORM, PROPERTIES, STRUCTURE, FUNCTIONS, AND RELATIONS.

THE fibrous tissue has received the several names of albugineous, tendinous, aponeurotic, ligamentous and dermoid tissue. It comprises an assemblage of organs, having various forms, serving different purposes, but all having the common character of being composed of distinct fibres, both firm and strong. Its principal divisions are,

1. Ligament.
2. Tendon.
3. Fibrous envelopes, &c.
4. Fibro cartilaginous bodies.

These several varieties do not form one continuous and connected whole, though Bichat and others have endeavored to fix a common centre. Bichat takes the periosteum as this centre, others the membranes of the brain, and others the aponeuroses.

The fibrous system is distinguished by its brilliant white color, great strength, so great as to have resisted effectually horse power, when applied to the extremities. It has little extensibility, breaking before it will stretch, very little elasticity, but is endowed with great flexibility, and resists putrefaction for a long time.

By *desiccation* it becomes "somewhat elastic, transparent, of a yellowish red color, and almost homogeneous, but by submitting it to the action of water, it recovers all its original characters."

Boiling reduces it to a soft, gelatinous condition, though at first, it is said, contracting it and making it more solid and elastic. The mineral acids reduce it to a pulpy state, and if concentrated, entirely dissolve it. Alkalies, it is said, loosen its texture, separate its fibres, and cause them to assume a diversity of colors.

A Fig. 28. B

The structure of this tissue is essentially fibrous, that is, it consists of threads or fibres variously arranged in its different divisions; some being parallel, some wavy, some crossed, others mixed, and some so very compact as to appear homogeneous.

In the fibrous tissue are distinguished two kinds of fibres, the white and yellow. The *white* (Fig. 28, A,) is described as presenting the form of "inelastic bands," of variable size, wavy in their direction, having numerous streaks longitudinally. It is reduced to gelatin by boiling, and, under the action of acetic acid, is seen by the microscope to swell up, become transparent, and exhibit oval corpuscles, which latter are believed to be the formative nuclei of this element. This white fibre is very abundant in tendons, ligaments, fibrous membranes, aponeuroses, &c.

The *yellow fibre* (Fig. 28, B,) presents the form of a cylinder; readily separates from its fellows in the longitudinal direction; breaks abruptly and curls upon itself, as seen in the figure, and differs from the white, in that boiling has little or no effect upon it. Its elasticity is said to be preserved for an almost unlimited period. From acetic acid having no effect upon it, it can always be distinguished from the white tissue. Various opinions have been entertained in reference to the ultimate structure of these fibres. Mascagni believed they were absorbent vessels, surrounded

Fig. 28. A represents the white fibrous tissue from ligament, magnified 65 diameters. *B* shows the yellow fibrous tissue from the ligamentum nuchæ.

by a vascular web. Beclard considers them as condensed cellular tissue, since maceration softens and reduces them to this structure. Isenflam supposes them to be cellular filaments, containing gluten and albumen; while M. Chaussier thinks they are primitive and peculiar. The microscope has measured the ultimate filaments into which the fasciculi are capable of being resolved, and determined it to be from the 1-30,000 to the 1-10,000 of an inch. The vital properties of the fibrous tissue, in the healthy state, are very obscure. It then evinces little or no sensibility, while in inflammation it is susceptible of the most acute pain. Its power of repair when injured or lost is considered to be very great.

In the embryo, this tissue, like all other parts, is soft and mucus-like in its appearance. It is distinguished about three months after impregnation. In the infant it presents a pearly white appearance, is more extensible than in the adult, yields more readily and is less liable to break. The common functions of the fibrous system are mechanical, and will be noticed more particularly under its several divisions, which we shall now take up separately.

LIGAMENTS.

Sydesmology (συνδεσμος, a ligament, λογος, discourse,) is the term applied to the study of the ligaments. Ligament (from *ligare*, to bind,) is so called because it ties the several bones together in the skeleton; the connection between any two constituting a joint, or articulation. Ligaments most distinctly represent the true character of the fibrous system. They are mostly situated at the extremities of all bones forming joints. Unfortunately, this term has also been applied to an entirely different structure, as to the serous membrane of the abdomen, whose reflections upon the liver, uterus, &c., are called the ligaments of these organs, simply from the fact of their keeping these parts in their natural positions, and not at all from the serous membrane being supposed to have any really *fibrous structure*. The ligaments are very numerous, and get their

names from a variety of circumstances, as from situation, use, attachment, direction, resemblance to certain things, &c. Examples of situation are seen in the lateral ligaments; of use, in the capsular; of attachment, in the sacro-sciatic; of direction, in the crucial; and of resemblance, in the coracoid, trapezoid, &c.

Ligaments may be arranged, according to the motion of the part in which they are found, into three divisions:

1. Articular, 2. Non-articular, 3. Mixed.

All these divisions have their fibres arranged in such a way as to assume one of two forms—either that of bundles, called the funicular, or that of membrane, the membraniform.

The articular ligaments are the most important; they belong to the different joints, tie together different bones, where there is motion, and present both the funicular and membranous forms, as seen in the humeral and femoral articulation. Here the membrane is called the capsular ligament, which is a sheath surrounding the articulating bones, binding them together, and having its inner surface lined by synovial membrane. The funicular ligament has its fibres collected in a rope or cord, which may be internal to the capsule, as the ligamentum teres of the thigh joint, or external, as the lateral ligaments of other joints. All these ligaments have one of their faces corresponding with the synovial membrane, the other to the surrounding cellular tissue, except those within the capsule, which have an entire covering of synovial membrane.

The non-articular ligaments are attached to different parts of the same bone, where there is no motion. They close notches, for the transmission of vessels and nerves, as the supra-orbital, or shut up foramina, for the attachment of muscles, as the obturator. Those closing notches are funicular; those shutting foramina are membranous; and both are without a synovial membrane.

The mixed ligaments partake of the characters of the other two, in belonging to different bones, like the articular, and

being destitute of a synovial membrane, like the non-articular. These are found in the interosseous spaces, and the sacro-sciatic ligaments belong to this class. Besides ligament, there are other elements entering into the constitution of joints, as bone, cartilage, fibro-cartilage, and synovial membrane. Each of these will be noticed in its proper place.

The different *forms* of articulation are arranged in three classes:

1. Diarthrosis, 2. Synarthrosis, 3. Amphiarthrosis.

Diarthrosis (δια, through, αρθρον, a joint,) is a movable articulation, and constitutes the great number of the joints. There are three varieties of this articulation, according to the degree of motion—enarthrosis, arthrodia, and ginglymus.

Enarthrosis (εν, in, αρθρον, a joint,) has the greatest range of motion of all the joints; it is called the ball and socket-joint, from the form of the bones, and the manner of their connection, as the hip and shoulder. *Arthrodia* is an articulation having a more limited range of motion, as the clavicle, ribs, articular processes of the vertebræ, radius and ulna, carpus, tarsus, &c. *Ginglymus* (Γιγγλυμος, a hinge,) is a hinge-like joint, where the motion is backwards and forwards, flexion and extension, as seen at the elbow, knee, and ankle. A variety of the hinge-joint, called the rotatory, is found between the radius and ulna. The *synarthrosis* (συν, together, αρθρον, a joint,) is the articulation without motion, where the bones are immovably connected together. There are four varieties of this joint:

1. The Sutura.
3. Schindylesis.
2. Harmonia.
4. Gomphosis.

The suture has several varieties; it is *serrated* when the bones come together and interlock, by processes at their margins, resembling the teeth of a saw, as in the coronal, sagittal, and lambdoidal sutures of the cranium. It is called *squamous* (*squama*, a scale,) when the bones overlap, as the temporal and parietal at the side of the head. *Harmonia*, (αρω, to adapt,) is a species of suture, where the con-

tiguous surfaces of bones come together, by rather a smooth surface and without any serration, as in the nasal, superior maxillary, and palate bones. *Schindylesis* (σχινδυλησις, a fissure,) is also a variety of suture, and consists of a fissure or gutter, by which one bone is received into another, as the vomer, the sphenoid, and ethmoid. *Gomphosis* (γομφος, a nail,) is that species of articulation where the bone is fitted to another, after the manner of a nail that is driven in a board. The teeth are specimens of this variety. *Amphiarthrosis*, (αμφι, both, ἀρθον, articulation,) as its name implies, partakes of the character of both the diarthrosis and synarthrosis; that is, it has a little of the motion of the former, and, like the latter, is without synovial membrane, as in the bones of the vertebræ.

The union of the scapula, or shoulder-blade, to the trunk, by means of muscle, called *syssarcosis*, (συν, together, σαρξ, flesh,) and *symphysis*, as in the symphysis pubis, sacro-iliac symphysis, &c., are also considered as belonging to this form of articulation. The motions of joints are reduced to four varieties—the angular motion, circumduction, rotation, and gliding. *Angular motion* comprises flexion, extension, adduction, and abduction. *Circumduction* is the small amount of motion which the head of the humerus and femur make with their articular cavities, when their extremities move in a large circle. *Rotation* is the motion which a bone describes upon its own axis, as illustrated in the movements of the radius upon the humerus, or the atlas upon the dentata. The *gliding* motion is found in the carpus and tarsus, and, in some degree, in all the joints, and is the simple movement of one articular surface upon another.

TENDONS.

The tendons have been already noticed under the head of the muscular tissue, and we will here only speak of the points in which they differ from ligaments. They differ in color—ligaments rather inclining to yellow, while tendons are pearly white. They differ in function—ligaments

simply tying bones together, while tendons are principally conductors of muscular power; and, lastly, they differ in their diseases—ligaments often suffering rupture and inflammation, tendons seldom.

The third division of the fibrous system is the

FIBROUS ENVELOPES.

There are several varieties of the fibrous envelope:

1. The Aponeurosis, or fibrous envelope of muscles.
2. The Sheaths of Tendons.
3. Periosteum.
4. Perichondrium.
5. Fibrous Envelopes of Brain and Nervous System.
6. Fibrous Capsules of other organs.
7. Compound Fibrous Membranes.

The aponeuroses, covering muscles, are called fasciæ, as the fascia-lata of the thigh, the fascia of the leg, arm, &c. In these cases the aponeurosis completely surrounds, and sends partitions between, the different muscles, down to the bones, thus forming an investment which keeps the muscles in their proper places, and thereby facilitates their actions. Aponeuroses are, in some instances, more partial, and cover but one surface, as the temporal fascia, or are situated simply between two portions of a muscle, as the occipito-frontalis of the head. They also give insertion to muscles, as the tensor vaginæ of the thigh. The aponeuroses are nearly as white and brilliant as the tendons; their fibres are thought to be more inflexible and resisting, and yielding less readily to maceration and boiling. Their *density* seems to be in proportion to the power, magnitude, and number of the muscles they bind down; the *sheaths* of *tendons* are general or partial; and assume the form of canals and rings—instances of which are best seen in the hands and feet. Here the vaginal ligaments are the sheaths, which, being attached to the bones of the fingers and toes their whole length, form the canals in which the tendons play, while those at the wrist and ancle, surrounding the tendons like rings, are the annular ligaments.

The *periosteum* covers the bones, and is commensurate in extent with the osseous system, enveloping every part of it except its articular surfaces. In infancy it is thick, and easily separated, while in the adult it is more compact and adheres strongly to the bones, sending processes into their substance. The periosteum protects the bones, conducts the vessels into their structure, connects the epiphysis with the general shaft of the bone, during infancy, and gives insertion to ligaments and muscles. It is restored when injured or destroyed.

The *perichondrium* is the periosteum of the non-articular cartilages, and has the same properties and uses.

The *fibrous-envelope* of the *brain* and nervous system is the dura mater, which lines the whole interior surface of the cranium, sending down prolongations into the brain, which divides it into several parts, and passing into the vertebral canal to surround the spinal marrow and the nerves. Several other organs have *fibrous capsules*; thus the eye has its sclerotica, the testicle its tunica albuginea, and the kidneys, liver, and ovaries their special fibrous envelopes.

There is another class, called the *compound fibrous* membrane, which consists of serous or mucous membrane, associated with the fibrous, as the pericardium and tunica vaginalis, which are fibro-serous; and the larynx and trachea, which are fibro-mucous.

The *yellow elastic* fibrous system derives its name from the yellowness of its color and the elasticity of its fibre. It is found in those parts where there is much resistance to overcome. The yellow ligaments of the vertebræ are of this class. The elastic coat of the arteries, of the excretory ducts, the coverings of the spleen, and corpora cavernosa, are also viewed as belonging to this division. It has less tenacity, but more extensibility, than the other fibrous tissues. Its chief physical property, however, is elasticity, which it possesses in consequence of the water it contains, for, when deprived of its water, it loses this property, and, when this is restored to it, it again recovers.

The *relations* of the fibrous system are numerous and important. We have seen it related with the osseous system, without which connection the skeleton would tumble to pieces, and the form, size, strength, and flexibility of the body consequently be lost. We find it attached to muscles, without which their properties of contraction could be exercised with but little advantage. We see it entering into the organs of respiration, where, if absent, air could not reach the lungs, and, consequently, the vital change of venous into arterial blood could not take place. And we also find the fibrous system connected with the brain and nervous system, the liver, the spleen, the kidneys; in a word, there is no organ or function with which it is not more or less intimately associated, and without it the whole machinery of life would stop.

CHAPTER IX.

THE CARTILAGINOUS TISSUE.

ANALYSIS.

DEFINITION, DIVISION, FORM, PROPERTIES, STRUCTURE, FUNCTIONS, RELATIONS.

THE cartilaginous tissue is readily known by its superior elasticity, its great hardness, only second to that of the bones, and by its whiteness and flexibility. It subserves the purpose of skeleton in some of the inferior animals, being the only substitute they have for bone. Cartilages are divided into the temporary and permanent; the former regularly disappearing at a determinate period of their growth, when they ossify and form the bones, the latter remaining as permanent cartilages during life, as in the ribs, larynx, &c. The permanent cartilages are divided into the articular, or those which have no perichondrium, such as are seen in the various joints, and into those which have this fibrous covering, as the cartilages of the ribs and ear.

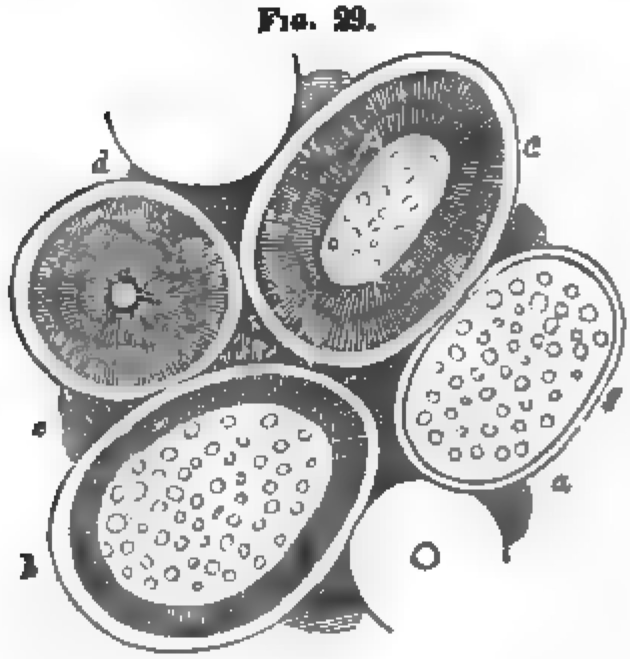
This tissue has a variety of *form*, some of the cartilages being long and narrow, others thin and broad, and all

more or less flattened. Boiling, at first, crisps, but continued, reduces cartilage to jelly. This is said to be true only of the articular cartilages, the others, having little or no gelatin, are not dissolved. Drying makes this tissue appear of a semi-transparent yellow color, diminishes its bulk, and destroys its elasticity. Cartilage contains a great quantity of water, upon which depends its properties of color, flexibility, volume, and elasticity, and which, when impaired or lost, may be recovered by restoring the water. Alcohol renders this tissue slightly opaque; acids, concentrated, dissolve it. Chemical analysis makes cartilage to consist of gelatin 44.5, phosphate of lime 0.5, water 55. Maceration and putrefaction are resisted for a longer time by this tissue than any other, except bone.

The *structure* of cartilage appears to be homogeneous, presenting, according to M. Beclard, neither "cavities nor canals, nor areolæ, nor fibres, nor laminæ, nor blood vessels, nor absorbents, nor nerves;" in a word, they seem to be destitute of every thing like organization. It is nevertheless certain there must be a species of circulation answering, at least, their mode of existence, as is evident in cases of jaundice, when these parts are deeply tinged with the yellow coloring matter of the bile, and in ossification of this tissue the bony matter is deposited in the centre of the cartilage, which could only be done by the circulation. Mr. Bayle remarks that although the cartilaginous tissue, at first sight, appears homogeneous, yet, on minute examination, small fibres may be discovered," and, when macerated for a long time, assumes the appearance of a "cellular net-work." In the embryo cartilages are soft, mucous, and transparent like jelly or glue. In the child they are yet very transparent, soft, and slightly elastic, and in the adult acquire the natural firmness, opacity, and all the properties which especially distinguish them; while later, in old age, they become more yellow, more opaque, less flexible, less elastic, more brittle, dryer, contain less water, and, in proportion, more earthy matter. Cartilage springs from cells like all other tissues. These cells are called

cartilage corpuscles, containing nucleii and nucleoli, situated in an amorphous substance from which arises the cytoblasts or germinal particles forming the cells. The cells are found to vary in their size, shape, and number, according to the cartilages examined. Those of the ribs measure from 1-650 to 1-430 of an inch in diameter, while in the cartilages of the joints they are from 1-1300 to 1-900 of an inch. Their shape is ovoidal, round or lenticular and notched. The cell cartilage is distinguished by a substance called chondrin, which resembles gelatin, but requires a longer boiling for its solution. It hardens on cooling, and looks like glue. It is not precipitated by tannic acid, in which it differs from gelatin. Acetic acid, alum, acetate of lead, and proto-sulphate of iron, precipitate chondrin, but have no effect on gelatin. Cartilage is supposed to be nourished by the agency of its cell, those nearest the blood vessels take the nutritive materials and hand it over to the next series, and those to the next, and so in regular succession till the whole is supplied.

FIG. 29.



The *functions* of cartilages are to supply the place of bone in some parts, and to connect and facilitate their motions in others. Cartilages are accidentally developed in various parts of the body, as in the lungs, arteries, semilunar valves, pleuræ, coverings of spleen, testicles, ureters, vagina, and in the substance of some organs, as the ovaries,

FIG. 29 represents a cylinder of bone filled with cartilage corpuscles; *b c* represents several lamina of bone and unossified cartilage corpuscles; *d* represents the process of ossification as complete, and the opening in the centre as the Haversian canal of the ossicle; *e* shows the interosseous space filled with bony matter.

and thyroid gland. Cartilage is also frequently completely transformed into bone, as the costal, connecting the ribs with the sternum. The *relations* of the cartilaginous system are very important and extensive. In the young state it represents the entire osseous system, and without it the skeleton could have no proper existence or motion. It also enters into the organs of voice and respiration. Hence the utility of this tissue, the close relationship and dependence of other tissues upon it, and, consequently, the well-being of the whole œconomy on its integrity and preservation.

CHAPTER X.

FIBRO-CARTILAGINOUS TISSUE.

This tissue, as its name implies, consists of both fibre and cartilage, uniting the tenacity of the former with the density and elasticity of the latter. It presents three varieties.

1. The membraniform as seen in the external ear, alæ of the nose, cartilages of the eyelids and the trachea.

2. The inter-articular, found between the bodies of the different vertebræ, at the clavicle, inferior maxillary, and knee-joints.

3. The trochleá for the gliding of tendons.

The cotyloid and glenoid ligaments, which deepen the articular cavities of the thigh and shoulder joints, belong also to this class.

The fibres of this tissue are said to run in every direction, some parallel, others interlaced and crossed, others concentric, and all having their spaces filled with cartilage. Desiccation makes it yellow and transparent like the ligaments. Boiling reduces it to gelatin. The first variety only has perichondrium, the others adhering to the bone or being covered by synovial membrane.

The *functions* of this system vary in different parts. We

find it assisting in forming the organ of the nose, ear, and trachea, and consequently taking part in the functions of respiration, hearing and smelling. By being placed between articular surfaces, it prevents concussion, and in the trochleæ, it facilitates the movement of tendons.

CHAPTER XI.

ERECTILE TISSUE.

THE corpora cavernosa, in the penis of the male, the clitoris of the female, the nymphæ, the tissues around the vaginæ, and the nipple in both sexes, are all regarded as specimens of the erectile tissue.

This tissue, it is believed, consists essentially of a plexus of varicôse veins, surrounded by a fibrous envelope. The cause of erection, or turgescence, in the penis and clitoris, called *turgor-vitalis*, has been ascribed to compression of the *vena dorsalis* against the symphysis pubis, and to the action of the ischio-cavernosi muscles. That such cannot be the cause in all cases, may be safely inferred from the fact that there is no such compression nor any such muscles acting upon the nipple where this erection equally occurs.

According to Gerber the venous plexus is traversed by numerous contractile fibres, whose contraction causes obstruction in the venous circulation, producing thereby the turgescence and erection. Valentin describes a tendinous tissue between the anastomosing veins, having muscles attached to it, which he supposes the active cause of the erection; but his reasons for regarding such structure as muscular, are not considered conclusive. Müller says the exciting cause is nervous irritation, proceeding from the brain and spinal marrow, or arising in the part itself, and that the pudic nerves are the means of transmitting the nervous influence; as from the experiments of Guenther, it seems the penis was incapable of erection when these nerves were divided. Muller has discovered a set of arteries which he

calls the helicine, that penetrate the cavernous substance and end abruptly in the venous cells, which he regards as chiefly concerned in the erection, but whose existence is denied by Valentin.

CHAPTER XII.

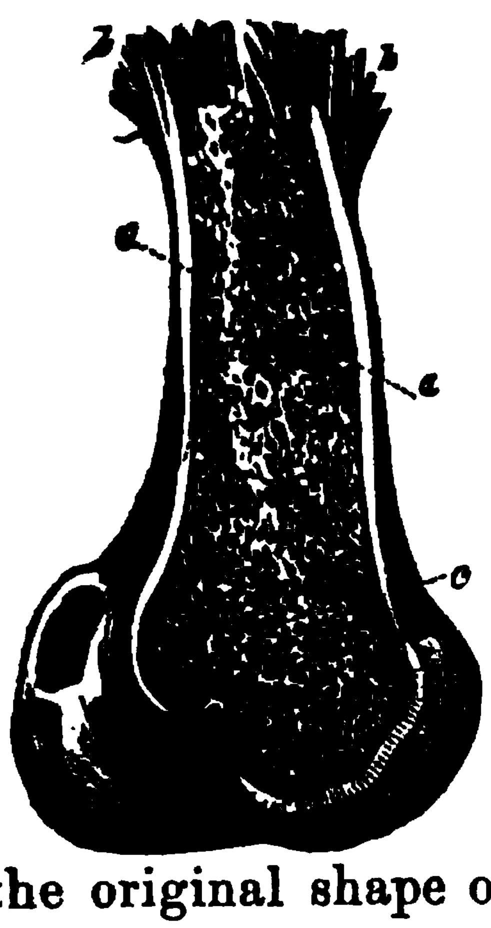
THE OSSEOUS TISSUE.

ANALYSIS.

DEFINITION, COMPOSITION, SKELETON, DIVISIONS, NUMBER, SITUATION, DENSITY, STRENGTH, SURFACE, STRUCTURE, DEVELOPMENT, GROWTH, CALLUS.

THE *bones* are the hardest of all the tissues; they constitute the solid frame-work of the body, are the passive organs of locomotion, give attachment to a variety of muscles, and afford protection to numerous viscera.

FIG. 30.



Bone consists essentially of two parts, an earthy and an animal; the earthy being chiefly phosphate of lime, the animal mainly gelatin. By subjecting bone to fire, the animal portion is consumed and the earthy left; presenting, however, the perfect shape of the bone, but being very brittle, easily reduced to powder and presenting the honey-comb appearance. When put in dilute muriatic acid, about 1 part of acid to 30 of water, the earthy portion is removed and the animal left, which also retains the original shape of the bone. The chemical analysis of bone, according to Berzelius, makes it consist of—

FIG. 30 represents the texture of bone after maceration in dilute acid. *a a* compact matter. *b b* The same split up, so as to show the longitudinal fibres Composing it. *c* Internal cellular or cancellated structure. *d* Bone seen under its articular cartilage.

Cartilage,	32.17	Fluoride of Calcium,	2.00
Insol. animal matter,	1.13	Phos. of magnesia,	1.16
Phosphate of lime,	51.04	Soda, chlo. of sodium,	1.20
Carbonate of lime,	11.30		

Vanquelin and Fourcroy have also detected iron, manganese, silex, alumina, and phosphate of ammonia.

These ingredients are found in bone every where, and under all circumstances, though the relative proportion of the respective parts often varies, not only in different bones but at different times in the same bone.

The bones of the cranium, especially the petrous portion of the temporal, furnish more calcareous matter than the rest of the bones of the same skeleton. To the predominance of the earthy matter, in the aged, do the bones owe their great brittleness; while, on the contrary, in children, it is deficiency of the earthy and predominance of the animal matter, which make the bones at that age so very flexible.

The bones collectively constitute the skeleton. When they are united by their own ligaments, left for that purpose, the skeleton is a *natural one.* When they are connected by wire or any other foreign substance, it is *artificial.*

The skeleton is divided into the head, trunk and extremities. The bones composing these great divisions are again divided, according to their *form,* into the *long,* the *flat,* or *broad,* the *short* and the *mixed.*

Specimens of the *long* bones are found in the extremities, as in the thigh, leg and arm. The *flat* compose the cranium and pelvis. The *short* are seen in the wrist, instep and spine; while the sphenoid and temporal bones present examples of the *mixed.*

The *number* of bones in the human body is not precisely agreed upon by anatomists, some making more and others less, owing to the period of life at which the calculation is made. The younger the subject, the more numerous are the bones, and as age increases, the bones run into each other and become fewer in number. Taking the adult period as the standard, the whole number may be estimated

at 211; not including, however, in this calculation, the teeth and the sesamoid bones. The former are separated from the skeleton for reasons to be given hereafter, and the latter are regarded as developments of the tendinous structure.

The head has 22 bones, 1 frontal, 1 occipital, 2 parietal, 2 temporal, 1 sphenoid, and 1 æthmoid, constituting the cranium; while the 2 superior maxillary, 2 palatal, 2 malar, 2 nasal, 2 lachrymal or unguiform, 2 inferior turbinated, 1 vomer, and 1 inferior maxillary, making 14, form the face.

The trunk has 56; 24 true or movable vertebræ, 1 sacrum, 4 caudal vertebræ or bones of the coccyx, 2 ossa innominata, 12 ribs on each side, and 1 sternum.

The hyoid bone stands by itself, at the upper part of the neck, and consists of three, sometimes of five, pieces.

The *superior* extremities have 68 bones, viz: 2 clavicles, 2 scapulæ, 2 humeri, 2 radii, 2 ulnæ, 16 carpal, 10 metacarpal, and 28 phalanges, forming the shoulder, arm, forearm and hand, of both upper extremities.

The *inferior extremities* have 64 bones, viz: 1 femur, 1 tibia, 1 fibula, 1 patella, 7 bones of the tarsus, 5 for the metatarsus, and 14 phalanges for each lower limb, consisting of the thigh, leg, and foot.

The *situation* of the bones is either superficial or deep. Examples of the former are seen in the tibia and clavicle, which, excepting a little cellular and adipose structure, are only covered by the skin; while the latter, as the thigh bone, are some distance from the surface, and have a thick covering of muscle.

Bones present different degrees of *density*, varying even in different parts of the same bone; those of the carpus and petrous portions of the temporal bone presenting specimens of the greatest density and compactness, while the long bones have their bodies or diaphyses compact, and their extremities loose or spongy. (Fig. 30.)

Under the head of structure, to be presently noticed, we shall see that the osseous fibres are brought either very

closely together and much condensed, or, on the other hand, are more or less widely separated, and intersect each other in every direction, so as to present the honeycomb appearance. The first or condensed state forms the *compact*, the second, the *cellular* or cancellated structure, of bone. The compact gives strength and firmness to bone, and forms its external osseous layer; while the cellular is delicate and spongy, and designed to support the medullary membrane and its marrow.

The *strength* of bones varies equally with their density, and that in different parts of the same bone. The thigh bone, for instance, is not of equal strength in its whole length; the body, having the compact tissue, is capable of resisting a greater degree of force than the extremities, which have only the light, spongy formation of delicate, reticulated structure. All the long bones have a hollow canal extending nearly their whole length, which is found to add greatly to their strength, at the same time increasing their lightness. This, Dr. Physick, in a very beautiful and simple manner, illustrated by taking a sheet of paper and rolling it into scrolls or hollow cylinders of various diameters. He found the power of sustaining pressure to increase, in a precise ratio with the increase of diameter, up to a certain point. Now, taking a similar sheet and rolling it into a solid cylinder, and comparing its strength with that of the hollow one, it was found that its capacity for sustaining weight, and its power of resisting pressure, were much less.

The doctor, by an equally simple experiment, shows that the use of the cellular arrangement, or diploe, between the two tables of the flat bones, is to give strength, by deadening the force of blows, and, as in the cranium, giving greater security to the organs they are designed to protect. The experiment consisted in taking a certain number of ivory balls and suspending them. When the first in the series was elevated several degrees and let fall against the second, the result was the elevation of the last ball to an angle nearly equal to the first. A ball made of the cellu-

lar structure of bone was now substituted for the middle one of ivory, and the series submitted to the same process; the impulsive power of the first ball was now found to be almost entirely destroyed on reaching the last.

All the bones present upon their *surface* impressions which are either regular or irregular, smooth or rough; this diversity depending upon the projections and depressions every where belonging to bones. They constitute most important practical points to the surgeon, as they form his guide in many operations, while they also give origin and insertion to muscles, and at the extremities of bones form the articular surfaces of joints. The projections from the surface of bones are called apophyses or processes, (απο, from, φυομαι, to grow,) in early life epiphyses, (επι, upon, φυομαι, to grow.) The apophyses are divided into those forming articulations, and those giving attachment to fibrous organs. Cloquet gives the following summary.

1st. Apophyses forming articulations.

Those belonging to movable articulations.

Heads, which are nearly hemispherical, as the head of the humerus and femur.

Condyles, which are broader in one direction than another, as the condyles of the femur.

Those belonging to articulations not having motion, dentations, or teeth-roots, &c.

2d. Apophyses affording attachment to fibrous organs, and named according to their general forms.

Impressions, unequal eminences, not much raised and extended in breadth.

Lines, unequal eminences, not very prominent, but extended in length, as the linea-aspera.

Ridges, resembling lines, but smooth and more distinct, as the superciliary ridge.

Bumps, when they are rounded, broad, and smooth.

Tuberosities and protuberances, when rounded and rough, as the tuberosity of the ischium, the bicipital protuberance, &c.

Apophyses named according to the bodies to which they are compared.

Spines, resembling a thorn, as the spinous processes of the vertebræ.

Styloid, in the form of a conical point.

Coracoid, like the beak of a crow.

Odontoid, or tooth-like.

Mastoid, like the nipple.

Apophyses named according to their uses.

Trochanters, or those subservient to turning, as the trochanter major, and minor of the thigh bone.

Orbitary, belonging to the orbit.

Apophyses named according to their direction and relative situation.

Oblique, *transverse*, anterior, &c. The cavities upon the surface of bones have two divisions.

1st. Articular cavities.

2d. Those which do not belong to articulation.

The first division includes the

Cotyloid, (κοτυλη, cup, ειδος, shape,) a cavity deep and round, as seen at the thigh joint.

Glenoid, (γληνη, shallow,) shallow cavities, like that at the shoulder joint.

Trochliform, when scooped in the form of pulleys, as in the elbow joint.

Faces, when nearly plane.

Alveoli, when of a conical form, as the sockets for the teeth.

The second division includes cavities not entering into articulation.

1. Cavities intended for the reception of parts.

Fossæ, when the entrance is wider than the bottom.

Sinuses, when it is narrower.

2. Cavities for the insertion of parts.

Impressions, when they are wide, unequal and shallow

Grooves, when extended in length.

3. Cavities for the passage of tendons.

4. Cavities formed by the impression of parts.

Gutters or *channels* corresponding to blood vessels.

5. Cavities subservient to transmission.

Notches, when superficial and formed in the edges of bones.

Foramina, when they pass through or perforate the bone.

Canals, when their passage is of great extent, as the vertebral or medullary canal.

Clefts or *Fissures*, if they are longitudinal and narrow.

The *structure* of bone consists of several elements.

By the naked eye the fibrous arrangement is observed, and the fibres, as already stated, assume two forms, the one forming the compact, the other the spongy or cancellated structure. A modification of the spongy, in the medullary cavity, receives the name of the reticular tissue.

The compact tissue occupies the outer surface of the bones, and has its fibres compressed so as to form a compact, firm and dense tissue.

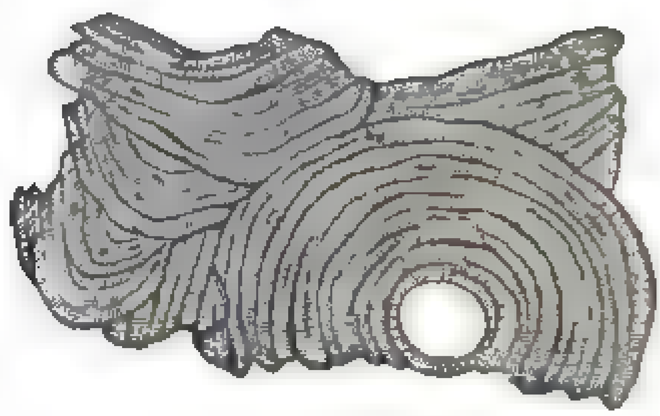
Bone, treated with nitric acid, is made soft and its fibrous character clearly shown. In the long bones the fibres arrange themselves longitudinally; in the flat, they diverge like radii from a certain point, while in the thick they are very irregular. The osseous fibres are found to be laminated as well as fibrous, that is, consisting both of filaments and plates or laminæ; and the intervals between them are only seen with the microscope. These, however, become gradually more and more distinct as they approach the extremity of the bone, and are there continuous with the cellular or reticulated tissue. Indeed, says Cruveilhier, "the compact tissue is nothing more than an areolar substance, the meshes of which are extremely close and much elongated." Diseases also frequently show the compact tissue changed into the spongy, and, *vice versa*, the spongy into the compact.

The spongy or honey-comb structure (Fig. 30) presents cells and areolæ of variable size and shape, all of which communicate, and consist of filaments and fine laminæ, crossing, uniting, and separating in every direction. These cells contain marrow, and hence are called

medullary cells. The cellular structure is only found to exist when ossification commences. The relative proportion of these two substances varies greatly even in the same bone; the compact predominating, as in the body of long bones, where strength is required, while the spongy prevails at the extremities, where extent of surface, for variety of motion, is needed.

The microscope makes more evident the laminated condition of bone, and reveals many other points in minute anatomy hitherto unknown. It shows the laminated structure in long bones to be arranged in concentric circles, while in the flat, the fibres run parallel with the surface. Between the laminæ a multitude of longitudinal canals, called, after Havers, their discoverer, the Haversian canals, are seen. They are narrow, cylindrical, form a net-work, connect with each other, and open externally upon the periosteum, and internally connect with the cellular structure and medullary cells. These canals are found to measure from 1-200 to 1-2500 of an inch, and contain blood-vessels and an oily matter, and are supposed to be simply miniature representations of the great medullary canal itself, having similar functions of receiving blood vessels and containing the fat.

Fig. 31.



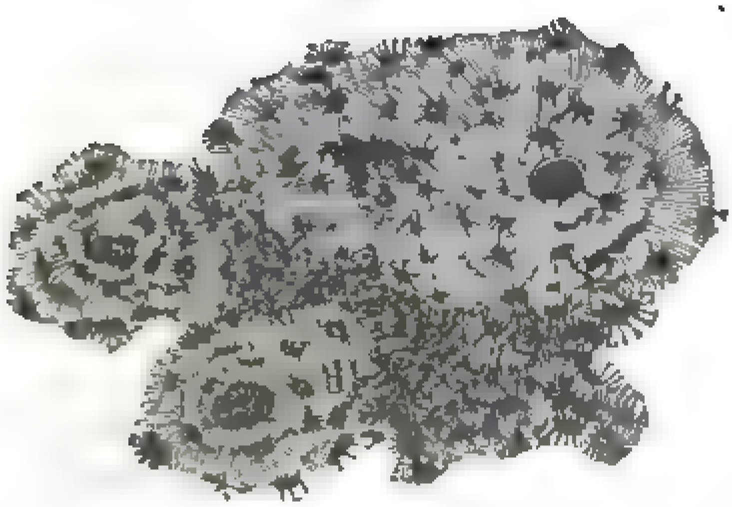
These Haversian or medullary canals are seen to be surrounded by from four to twelve concentric lamellæ or osseous plates, intersected or perforated by minute tubes called *calcigerous*, which are supposed to contain the earthy matter; also between the laminæ are seen, on a transverse section of bone, little cavities called, after their discoverer, the corpuscles of Purkinje, which also receive the names of bone corpuscles and lacunæ. (Fig. 32.) These

Fig. 31 represents the concentric lamellæ of bone, taken from a transverse section of the tibia, after maceration in weak muriatic acid.

cavities contain granular matter, and have the calcigerous tubes running into or passing from them in a stellate form.

There are also certain lines or striæ described by Deutsch, but which Wilson, in his observations, makes identical with the calcigerous tubuli.

FIG. 32.



The bones have two membranes, the one covering their outer surface, called the periosteum, the other lining the interior of their cavity, called the medullary membrane. The *periosteum* is a fibrous membrane, and has been described under the head of the fibrous system. It covers every part of the bone except the articular surface; it is continuous, at the extremities, with the ligaments, loosely attached in infancy, but closely adherent in adult bone.

The periosteum is very vascular, and both its fibres and vessels pass together into the bone.

The *medullary membrane* is an exceedingly delicate membrane, composed of a very fine, soft, cellular tissue, containing numerous minute blood vessels. It can be traced lining the whole interior of the medullary cavity, and extending into the medullary cells, and, it is believed, into all spongy structure wherever found. This membrane forms vesicles for containing the marrow, which fills the reticular spaces in bone. In birds these are occupied by air. Both it and the periosteum accompany the blood vessels through bone. Besides secreting the marrow, this membrane serves to nourish the bones.

The *blood vessels* supplying bones are numerous. The arteries are referred to three classes. 1st. Those which

FIG. 32 represents a transverse section of bone with the Haversian canals and lacunæ.

enter the bone from the periosteum, by the numerous foramina upon its surface. 2d. Those which enter by the larger foramina at the extremities of the long bones, and at different points upon the surface of others; while the 3d, called nutritious arteries, enter the long bones by a single foramen, and that near the centre of each.

The arteries of the first two classes ramify minutely throughout the whole of the compact and cellular structure. The *nutritious artery* is much larger, and passes single through the compact structure to the medullary cavity, where it divides into two branches, an ascending and descending, which ramify upon the medullary membrane in countless capillary vessels, and anastomose freely with the other two classes.

The veins are numerous, those accompanying the nutritious artery pass out of the same foramen, and return the blood from the medullary membrane. The veins which receive the blood from the other two classes of arteries do not attend them, but pass out by numerous distinct openings found upon the surface of the bones, and after a short course join the general circulation.

Lymphatics have been demonstrated in the medulla, but not with certainty in bone.

Nerves have been traced along the nutritious arteries, but not into the substance of the bone itself.

DEVELOPMENT OF BONE.

"In the human fœtus and other animals, before the time of birth," says John Bell, "instead of bones there are only cartilages of the form of the future bone. The whole fœtus appears to the eye like a mere jelly. The bones are a pure, almost transparent and tremulous jelly; they are flexible, so that a long bone can be bent into a complete ring, and no opacity or spot of ossification is seen."

The development of bone consists of three stages—

1. The Mucous. 2. The Cartilaginous. 3. The Osseous.

The mucous stage presents bone, like all the other tissues, in the earliest period of the embyro, as one homoge-

neous fluid mass, not having any characters by which the one can be distinguished from the other.

About the expiration, however, of the first month after conception the mucous stage becomes converted into the cartilaginous, which greatly increases the consistence of bone, and is the commencement of form in the fœtus. Agreably to the observations of Bichat and Scarpa, the cartilaginous condition presents two peculiarities. The first is, that during the formation of cartilage we do not see the longitudinal striæ of the long bones, the radiated of the flat, nor the mixed of the thick, which distinguish the osseous or third stage. The second peculiarity is, that all those bones which are to be united by cartilage in the adult skeleton, are in one piece, as those of the vertebræ and pelvis, while those which are to be united by ligament, and, consequently movable, are isolated, as the femur, tibia, &c.

The cartilaginous condition is complete at the end of the first or beginning of the second month, when the third or osseous stage commences. This event is announced by the arrival of red blood, which first shows itself in the centre of the cartilage, and the spot receives the name of the "*punctum ossificationis*," or point where ossification first commences. It appears that until this period it is not in direct relation with the blood, but, according to Carpenter, is surrounded by blood vessels which have "large ampullæ or varicose dilatations," from whence, and by imbibition, it is nourished.

The manner of ossification is somewhat modified in the three classes of bones. In the long bones there is first seen a central ring, whose cavity is the commencement of the medullary canal. This ring, forming the bony nucleus, gradually grows in length and thickness till the period of birth arrives, when we have the body or diaphysis generally finished. The epiphysis, or extremities of the long bones, do not commence ossifying till after birth, when we observe the point of ossification, as in the body, occupying the centre and extending towards the shaft. This process is not entirely complete, so that the different parts become

fused into one solid bone, till, according to the observations made, the individual has advanced to the sixteenth or eighteenth year of age, or even till later in life.

Ossification of the *flat bones* takes place between membranes, but, nevertheless, in cartilage also, which, however, is so small in quantity as to lead some to deny its existence. The point where the bony matter is first deposited depends on the bone being either single or compound in its nature. The parietal has one point of ossification, the frontal two, and the occipital several, from which points the osseous fibres radiate in every direction, till, at the period of birth, we have the whole bony casement for the head complete, excepting the fontanelles, which are not closed till the third year after birth.

The *thick bones* have one or more points of ossification, according as they are either single or double. The carpus and tarsus present specimens of the former variety, while the bones of the vertebræ furnish examples of the latter.

There yet remains great obscurity in regard to the precise manner in which cartilage is changed or becomes bone. The microscope shows cartilage to contain, or, as Von Behr expresses it, consist of a mass of homogeneous cells, cartilage cells, in the centre of which the medullary canaliculi or Haversian canals are formed, surrounded by capillary vessels. In the parietes of these canals and in the lamellæ, the lacunæ or corpuscles and the calcigerous tubes appear, after which the deposit of osseous matter seems to take place. The cartilage cells are regarded as the basis of this change. Ossification does not commence at the same time in all the bones. At the end of the first month the clavicle and lower jaw are found to be partly ossified; at the end of the second, the bodies of the long bones, the ribs, vertebræ, base of the skull, and pelvis have commenced ossifying; and from this time to that of birth, there are only a few in which ossification has not begun, such as the patellæ and a few bones of the tarsus and carpus. The ossific process is much more rapid in some bones than others, and in some parts of the

same bone; thus, the body of a long bone is completed a very considerable period before its extremity.

The *growth* of bones occurs and steadily progresses, as that of every other tissue, till the individual reaches the full stature; and this is accomplished by successively adding new matter to the old.

Mr. Jno. Hunter showed that the long bones grew by the addition of osseous matter at their extremities. This he proved by boring a hole at each extremity in the tibia of a pig, and inserting a shot in each, The distance between the two holes was accurately measured. After some months the same bone was again examined, and it was found that the distance between the shots was precisely the same, but that the extremities had extended very considerably.

The *flat* bones grow in breadth by a deposition at their margins, while the *thickness* of bone is believed to depend upon a secretion from the internal surface of the periosteum.

When the full size of the bones has been attained, the subsequent changes which occur are those of interstitial deposit and absorption.

Formation of Callus.—Callus is the mode of union between fractured bones, and resembles very much the original process in the formation of bone.

When the swelling subsides and the effusion of blood is absorbed, coagulable lymph is poured out in the cavity of the fracture. This corresponds to the first or mucous stage in the fœtal bone. An osseous ring is seen to encircle the place of fracture, while in the interior there is found an osseous pin. These are simply temporary arrangements, which are removed by absorption, when the bones begin to coalesce and become fused the one into another.*

* The recent observations of Messrs. Paget, Stanly and Dr. Hamilton throw great doubt on this statement of Dupuytren, in regard to *provisional callus*. In the lower animals, whose fractured limbs are subjected to so much greater motion than ours, and which, under such circumstances, secrete so much more bony matter, this account of the process of repair is undoubtedly correct; but in man, according to these more recent observers, no provisional callus has been formed, unless undue motion and excitement has induced irritation. The

The periosteum, with some, has the sole credit of forming callus; but this cannot be entirely true, as instances have occurred where the periosteum has been stripped off, and yet the fractured bones have united, callus has been formed, and the periosteum itself again restored. Bichat supposes that where the bones are not kept in contact, granulations spring up, and form first a gelatinous deposit, then cartilage, and, finally, bone, when the fractured ends are perfectly restored.

The tissues composing the letters of the alphabet, and which have just been examined, are variously combined to form the different organs of the body, constituting the language of anatomy, which introduces us to the Second Part, beginning with the head.

coagulable lymph is effused between the broken ends of the bone, and the process goes on like adhesion any where else, with this difference, that phosphate of lime is afterwards deposited in the new tissue. *See Ranking's Abstract*, 1850, *and Buffalo Medical Journal for February*, 1853.

PART SECOND.

THE LANGUAGE OF ANATOMY.

I. THE HEAD.

PART SECOND.

CHAPTER I.

PASSIVE ORGANS OF THE HEAD.

THE BONES.

The head is divided into cranium and face. The former consists of eight distinct bones: one frontal, two parietal, one occipital, two temporal, one ethmoid, and one sphenoid. These, when united, in consequence of their peculiar form, strength, and structure, are well adapted to receive the brain, and guard it from injury.

The face has fourteen bones: two superior maxillary, two malar, two palatal, two lachrymal, two nasal, two inferior turbinated, one vomer, and one inferior maxillary bone. These contain most of the organs of sense.

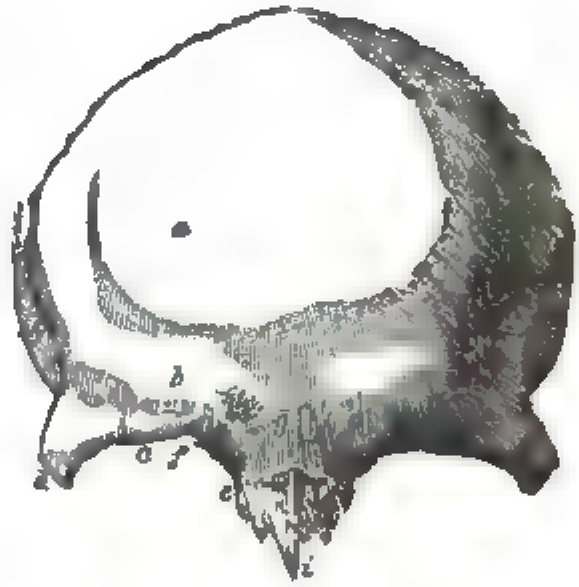
SECTION I.

BONES OF THE CRANIUM.

Frontal Bone—(*os frontis.*) The frontal bone (Fig. 33) is *situated* at the anterior and upper part of the cranium. Its *form* is semi-circular. Its *division* is into two parts, the superior or frontal, and the inferior or orbital. The frontal portion has two *surfaces*, an external and internal. The *external surface* is anterior, smooth and convex. Along the median line there is an elevation, not always distinct, corresponding to the original separation of the fœtal bone, into two equal parts, by the frontal suture, which sometimes continues in the adult bone. At the lower part of this line of division, is the *nasal prominence*, which terminates in a rough edge, for articulating with the nasal process of the superior maxillary and nasal bones. The *nasal spine*

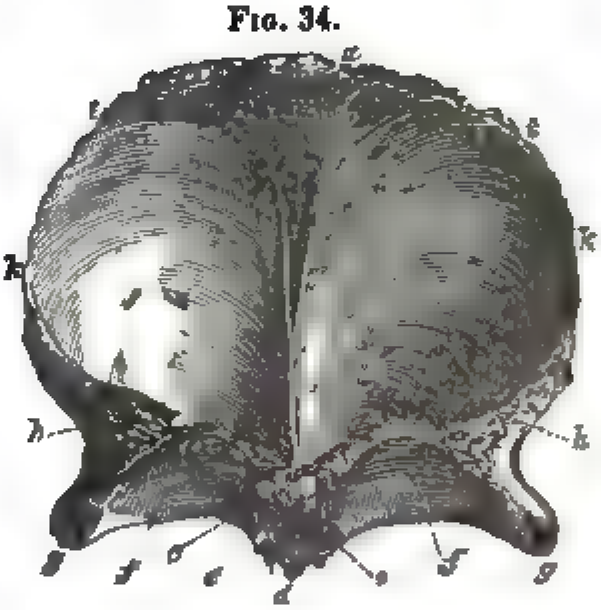
or *process* arises from the centre of this rough edge, and supports the ethmoid bone behind and the nasal bones in front.

Fig. 33.



On either side of the median line and about the centre of each lateral half, is the *frontal eminence.* Above this the surface is smooth, below it is the *superciliary arch,* which supports the eye-brow ; and below this again is the upper margin of the orbit, the *supra-orbital ridge.* This ridge terminates at its outer end in the *external angular process,* and at its inner, in the *internal angular process.* At the inner third of this ridge is a *notch,* converted into a foramen by a ligament, for transmitting the *supra-orbital* vessels and nerve, and just above its inner third is the prominence of the *frontal sinus.*

Fig. 34.



On the *internal surface,* the median line marks the

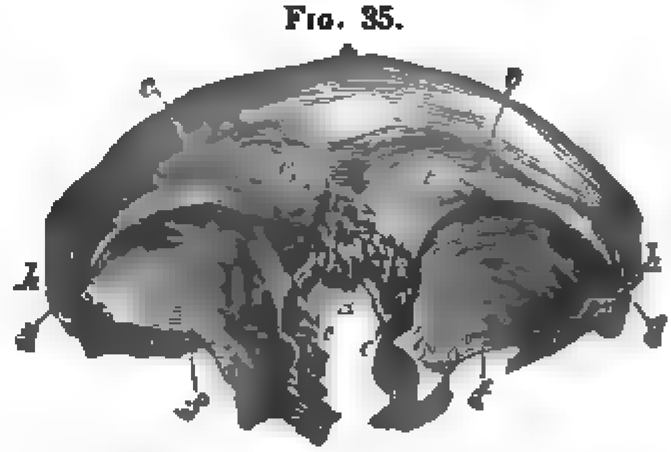
Fig. 33 presents a front view of the Frontal Bone. *a* Frontal protuberance of right side. *b* Superciliary ridge. *c* Supra orbital ridge. *d* External angular process. *e* Internal angular process. *f* Supra orbitar notch or foramen. *g* Nasal protuberance. *h* Semi-circular ridge for temporal muscle. *i* Nasal spine.

Fig. 34 presents a view of inner surface of Frontal Bone. *a* Coronal suture for joining frontal and parietal bones. *b* Ridge for attachment of falx-major. *c* Foramen cœcum. *d* Nasal spine. *e* Openings of the frontal sinuses. *f* Orbitar plates. *g* External angular process. *h* Serrated surface of sphenoid bone. *i* Line of junction of parietal bones. *j* Depression for glands of Pacchioni. *k* Squamous portion of temporal bone.

course of the *superior longitudinal sinus* by a groove. The inferior portion of this groove presents a ridge to which the *falx major* is attached. And at this point where it joins the ethmoid is seen a small hole, the *foramen cæcum*, for transmitting a vein which communicates with the nasal veins, and for lodging a process of the dura-mater. On either side of the median line, many eminences and depressions are observed, which correspond to the convolutions of the brain, called *mammillary eminences*, and *digital fossæ*.

The *circumference* is rough and serrated to unite with the parietal bones. At its superior border the internal table is deficient, and rests upon the junction of the two parietal bones above; while, at the sides and below, the external is wanting and is overlapped by the parietal.

FIG. 35.



The *inferior* or *orbital* division of the frontal bone presents in its centre the *æthmoidal notch*, in front of which is the nasal spine; and on either side, the orifices of the frontal sinuses. It communicates with the cells of the ethmoid by means of its edges, which are cellular. Along the margins of this notch, where it unites with the ethmoid, are two foramina, the *anterior* and *posterior orbital*, the first transmitting the nasal twig of the *ophthalmic nerve* and anterior ethmoidal artery—the second the posterior ethmoidal artery.

The *orbital processes*, on either side of this notch, are triangular, having the apex behind, smooth and concave below, rough and convex above. Near the external angular process, each of them has a depression for the lachrymal

FIG. 35 presents a view of the lower part of Frontal Bone. *a* Line where the two halves of the bone join. *b* Frontal protuberances. *c* Supra orbitar notch. *d* Nasal spine and space occupied by the æthmoid bone. *e* Frontal sinuses. *f* Orbitar plates. *g* External angular process. *h* Surface for temporal muscle.

gland, and near the internal, one for the pulley of the superior oblique muscle of the eye. Instead of a depression, there is sometimes a small eminence here.

The frontal bone has seven foramina: 2 *supra orbital*, which are special; 2 *anterior* and 2 *posterior orbital*, with 1 *foramen cæcum*, which are common to both the ethmoid and frontal bones.

The processes are nine: 1 *nasal*, 2 *orbital*, 4 *angular*, and 2 *superciliary*.

The *structure* consists of two compact laminæ of bone, called the *external* and *internal tables*, with an intervening cellular substance, the *diploe*.

The *development* of the frontal bone takes place by two points of ossification, one for each frontal eminence, or rather in the orbital arches, a little before that of the vertebræ, whence the rays radiate to the circumference. At birth the frontal bone still consists of two pieces, which during the first year unite along the median line by the frontal suture, which suture however sometimes remains permanent through life.

FIG. 36.

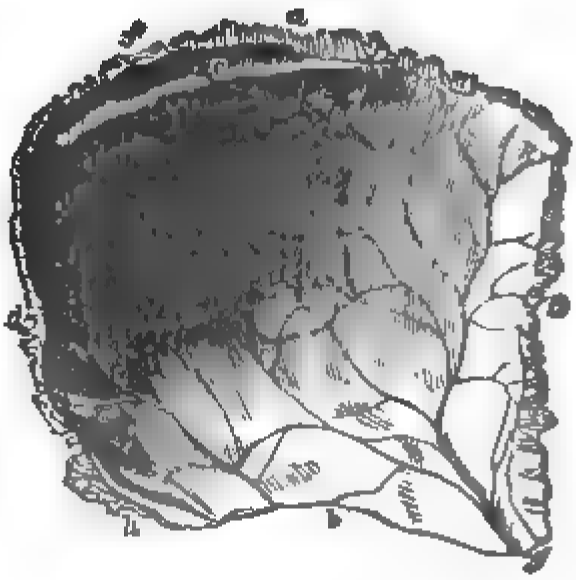
The *articulations* of this bone, are with four of the cranium, viz: the 2 parietal, the sphenoid and ethmoid; and eight of the face, viz: 2 nasal, 2 superior maxillary, 2 malar and 2 lachrymal.

Parietal Bones—(*ossa parietalia*.) The parietal bones are *situated* upon the lateral and superior parts of the cranium. They are symmetrical. Their *form* is quadrilateral; their external

FIG. 36 represents external surface of left Parietal Bone. *a* Superior or sagittal surface. *b* Squamous or inferior surface. *c* Coronal or anterior surface. *d* Lambdoidal or posterior surface. *e* Ridge where temporal muscle is attached. *f* Parietal foramen. *g* Inferior anterior angle. *h* Inferior posterior angle.

surface is smooth and convex, in the centre of which is the *parietal protuberance.* On either side of this protuberance, and extending in an arched direction transversely across the bone is the *temporal ridge;* below this ridge the temporal muscle is attached, above the aponeurosis of the occipito-frontalis.—The *inner* or *cerebral surface* is marked by the middle artery of the dura mater, and the convolutions of the brain. The trunk of this artery is seen in the anterior inferior angle of the bone, lodged in a groove, and branching upwards and backwards.

FIG. 37.



The *circumference* presents *four edges* and *four angles*, the *anterior edge* is serrated and unites with the frontal bone in the coronal suture. The *posterior* is very irregular and joins the occipital in the lambdoid suture. The *superior* is the longest and meets its fellow on the middle line in the sagittal suture. The *inferior* is the shortest, is thin, and unites with the temporal by the squamous suture.

Of the angles, the *anterior superior* is nearly straight; this, in the infant is wanting, the *anterior fontanelle* or opening taking its place. This opening is four-cornered, and is made so by a similar deficiency in the superior projecting points of the frontal bone. The *anterior inferior angle* is long and curved, and unites with the sphenoid bone. The *posterior superior* is rounded, and by its deficiency forms the *posterior fontanelle.* The *posterior inferior* is very irregular and unites with the mastoid portion of the temporal.

FIG. 37 represents internal surface of left Parietal Bone. *a* Sagittal suture, *b* Line for squamous suture. *c* Coronal suture. *d* Lambdoidal suture. *e* Groove for superior longitudinal sinus. *f* Parietal foramen. *g* Inferior anterior angle and groove for middle artery of dura mater. *h* Inferior posterior angle.

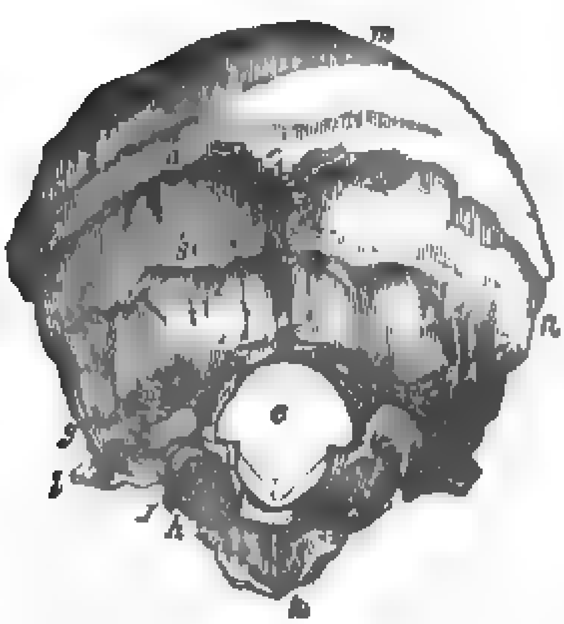
Along the *sagittal suture*, on the interior, is a *groove* for lodging the *superior longitudinal sinus*.

The *structure* is thin and consists of two *compact tables* and an intervening *diploe*. The *development* takes place by one point of ossification in each parietal protuberance, commencing about the seventh or eighth week.

The parietal *articulates* with five bones, the frontal, occipital, temporal, sphenoid, and its fellow.

Occipital Bone—(*os occipitis*.) The occipital bone is *situated* at the posterior inferior part of the cranium Its *form* is rhomboidal. It has two *surfaces*, an external and internal. The *external* is irregularly convex, and has near its centre the *external occipital protuberance*, to which the cervical ligament is attached. On either side extends, transversely, the *superior transverse ridge*, to which the trapezii and posterior bellies of the occipito-frontales muscles are connected. A short distance below is the *inferior transverse ridge*, and below this again, on the inferior surface is the *foramen-magnum*. The space between the two ridges is occupied by the complexi and splenii muscles. The inferior ridge and the space between it and the foramen magnum, gives attachment to the posterior recti and superior oblique muscles.

FIG. 38.



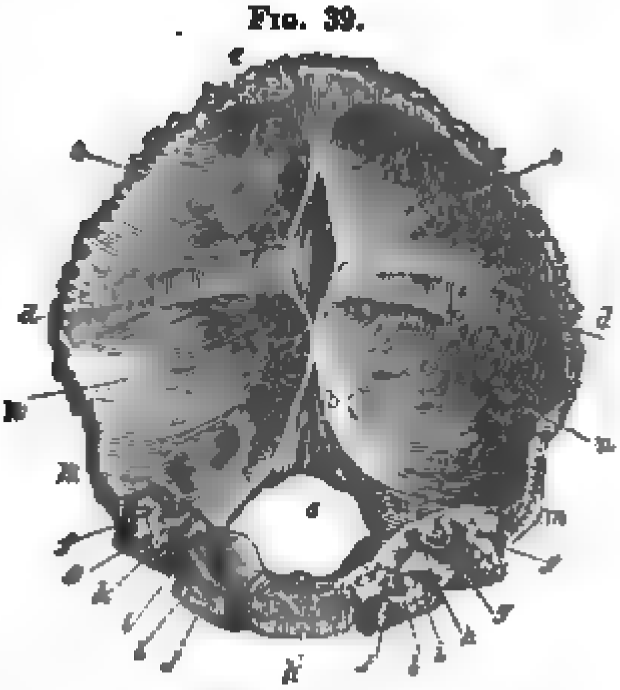
The *foramen magnum* has leading to it from the occipital protuberance, a *vertical ridge*. Its shape is oval, and it

FIG. 38 represents the external surface of the Occipital Bone. *a* Superior semi-circular ridge. *b* External occipital protuberance. *c* Point where the ligamentum nuchæ is attached. *d* Inferior semi-circular ridge. *e* Foramen magnum. *f* Condyle of the right side. *g* Posterior condyloid foramen. *h* Anterior condyloid foramen. *i* Jugular eminence. *j* Part of jugular foramen. *k* Basilar process. *l* Where odontoid ligaments are attached. *m* Surface for parietal bones. *n* Surface for mastoid portion of temporal bone.

transmits the spinal marrow and its membranes, the vertebral arteries and the spinal-accessory and sub-occipital nerves. In front of it is the *cuneiform* or *basilar process*, which extends forward upon the base of the cranium to unite with the sphenoid bone. The inferior surface of this process is rough and gives attachment to the pharynx, and superior and middle constrictor muscles.

On each side of the foramen magnum and near its forepart, are the two *condyles* for articulating with the atlas. They are smooth oblong processes which converge anteriorly, and look downwards and outwards, posteriorly. In front and at their base, is the *anterior condyloid foramen*, for transmitting the ninth or lingual nerves, and behind is a small foramen, the posterior condyloid, for the passage of a vein to the lateral sinus. Each condyle has on its outside the *jugular eminence* or *transverse process*, which forms the posterior boundary of the *foramen lacerum basis cranii posterius*, and to which is attached the rectus lateralis muscle.

FIG. 39.



The *internal* or *cerebral* surface is concave, and intersected by the *crucial ridge*, which divides it into four *occipital fossæ*, two superior for lodging the posterior lobes of the cerebrum, and two inferior for the cerebellum. In the centre where these ridges cross each other, is the *internal-occipital protuberance*,

FIG. 39 represents the internal surface of the Occipital Bone. *a* Foramen magnum. *b* Ridge for falx-minor. *c* Internal occipital protuberance. *d d* Lateral branches of the occipital cross, and depression for lateral sinus. *e* Surface for parietal bones. *f* Jugular eminence. *g* Jugular fossa. *h* Internal opening of condyloid foramen. *i* Surface for petrous portion of temporal bone. *j j* Condyles. *k* Anterior extremity of cuneiform process. *l l* Exterior edge of basilar gutter. *m m* Surface for mastoid portion of temporal. *n n* Cavity for Cerebellum. *o o* Cavity for posterior lobes of cerebrum.

which corresponds to the *torcular Herophili.* The *transverse ridge* has attached to it the *tentorium,* and is grooved for the *lateral sinuses.* The *vertical ridge* has attached to its superior part the *falx cerebri,* and to its inferior portion the *falx cerebelli.* The *cerebral* surface of the *basilar process,* is concave and supports the pons varolii and basilar artery.

The foramina are seven: 5 proper and 2 common. The proper are the 4 *condyloid,* 2 *anterior* and 2 *posterior,* and the *foramen magnum.* The common are the 2 *foramina lacera posteriora.* The processes are seven: 1 *cuneiform,* 2 *condyles,* 2 *jugular,* and 2 *occipital protuberances.*

This bone has *four angles:* a *superior,* which unites with the parietal bones, an *inferior,* which is attached to the sphenoid; and *two lateral,* which are blunt, and occupy the spaces between the mastoid portion of the temporal and posterior inferior angle of the parietal bones.

The *structure* consists of two compact tables and an intermediate diploe. The tables are so compact and thin in the fossæ, as to be diaphanous. The spongy tissue prevails in the processes. This bone is firm and hard, and in many places thick.

Its *development* is from seven points: one for the basilar process, one for each condyle, and four for the superior part. Ossification begins in the superior portion before it does in the vertebræ, by four osseous points, two above and two below the occipital protuberance, which soon unite to form a single piece. At birth the occipital bone is seen in four pieces, which become united to each other from the fourth to the sixth year, and with the sphenoid by the basilar process, about the twentieth year.

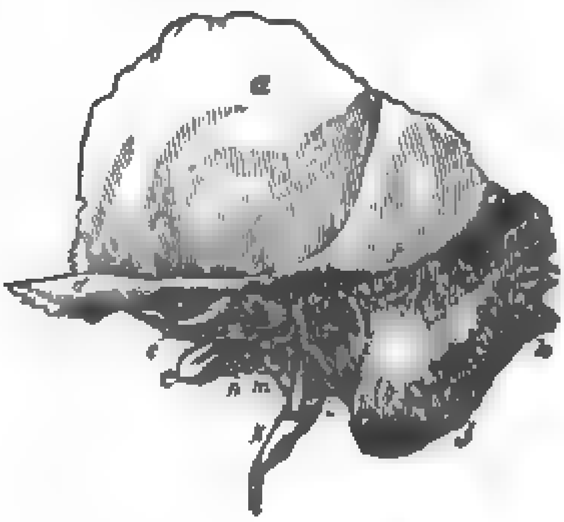
The occipital bone is *articulated* with six bones: the sphenoid, 2 temporal, 2 parietal and the atlas.

Temporal Bones—(Ossa Temporum, Bones of Time.) The *situation* of the temporal bones is at the side, middle and inferior parts of the cranium. The *form* is very irregular, and each is divided into the *squamous, mastoid* and *petrous* portions.

The *squamous, or scaly* part, forms the superior divis-

ion. Its external surface is flat; forms a portion of the *temporal fossa*, and gives attachment to the temporal muscle. Its internal surface has depressions for the convolutions of the brain, and a *groove* for the posterior branch of the middle meningeal artery.

FIG. 40.



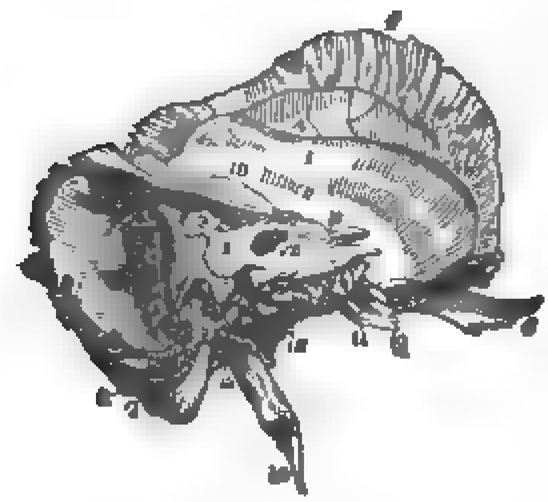
It is bounded above by a somewhat semicircular edge, which overlaps the parietal bone—and below by a long and curved process, with its convexity outwards, called the *zygoma*, or *zygomatic process*. This process is horizontal, and arises by two roots—the one runs transversely, is covered by cartilage, and forms the anterior boundary of the glenoid cavity—the other passes horizontally backwards, forming the outer boundary of the glenoid cavity, and is continued on and lost in the upper part of the mastoid process. This posterior root gives off a middle branch, which passes into the glenoid fissure, and partially forms the posterior wall of the glenoid cavity. At the junction of the horizontal and transverse roots there is seen a small *tubercle*, giving attachment to the external lateral ligament of the lower jaw—the anterior extremity of the zygoma is serrated and rests on the malar bone. Behind the transverse root is the *glenoid cavity*, which is divided by a fissure called the *Glasserian*—that portion of the glenoid cavity in front of this fissure is the proper articulating surface of the lower jaw, while that behind the fissure is occupied by a portion of the parotid gland—the fissure has attached to

FIG. 40 represents external surface of left Temporal Bone. *a* Squamous portion. *b* Mastoid portion. *c* Extremity of petrous portion. *d* Zygomatic process. *e* Tubercle in front of articular surface for condyle of lower jaw. *f* Temporal ridge, posterior portion. *g* Glenoid fissure. *h* Mastoid foramen. *i* Meatus auditorius externus. *j* Digastric fossa. *k* Styloid process. *l* Vaginal process. *m* Glenoid foramen. *n* Groove for the Eustachian tube.

it the capsular ligament of the lower jaw, and gives passage to the corda tympani nerve, the laxator tympani muscle, and the processus gracilis of the malleus.

The *mastoid*, so called from its resemblance to a nipple, is situated at the posterior and inferior part of the bone. It is a rough and depending process, having on its internal aspect two grooves—the one for giving origin to the *digastric* muscle—the other, a little posterior, transmits the *occipital* artery. The outer surface of this process gives attachment to the sterno-cleido-mastoideus muscle; on the posterior part of this process is generally seen the *mastoid foramen*, for transmitting the mastoid artery and vein.

FIG. 41.



The cerebral surface of this process is concave, and deeply grooved for lodging the lateral sinus. The third or petrous portion, named from its stony hardness, is *situated* between the squamous and mastoid, and proceeds forwards and inwards into the base of the cranium. Its *form* is triangular, with the base posterior, and presents three surfaces, one external or inferior, and two internal or cerebral.

On the inferior surface are noticed the following points: first and most prominent, the *styloid process*, a long, slender projection, sometimes two inches in length, giving attachment to the three styloid muscles and two ligaments.

Behind and at the root of this process, between it and

FIG. 41 represents the cerebral surface of the Temporal Bone. 1 Squamous portion. 2 Mastoid. 3 Petrous portion. 4 Groove for the middle meningeal artery. 5 Edge of squamous suture. 6 Zygomatic process. 7 Digastric fossa. 8 Occipital groove. 9 Groove for lateral sinus. 10 Superior petrous sinus. 11 Opening of the carotid canal. 12 Internal auditory foramen. 13 Aqueduct of the vestibule. 14 Styloid process. 15 Stylo mastoid foramen. 16 Foramen caroticum. 17 Spine dividing the jugular vein from the eighth pair of nerves. 18 Vidian foramen. 19 Where the levator palati and tensor tympani muscles arise.

the mastoid is the *stylo-mastoid foramen*, for transmitting the facial nerve, or portio dura of the seventh pair. This foramen is the lower aperture of the *aqueduct of Fallopius*. The styloid process is surrounded by a process at its root, very prominent anteriorly, called the *vaginal*, which separates the glenoid cavity from the carotid foramen, and foramen lacerum posterius.

In front and obliquely to the inside of the styloid process is the *foramen caroticum* leading into a canal, the *carotid canal*, which is first vertical, and then proceeds forwards, inwards and upwards, and opens within the cranium, by the side of the body of the sphenoid bone. It gives passage to the carotid artery and branches of the sympathetic nerve. In front of the carotid foramen is a rough surface for the origin of the levator palati muscle. By the side of the styloid process is a vertical ridge, within and posterior to which is a deep cavity called the *jugular fossa*. This, with a corresponding one in the occipital bone, constitutes the *foramen lacerum posterius*, through which passes the eighth pair of nerves and the lateral sinus, the nerves being anterior and separated from the sinus, which is posterior, by the *vertical* or *jugular spine*. Upon this ridge is described the opening of the aqueduct of the cochlea. The angle between the squamous and petrous portions is occupied by the *spinous process* of the *sphenoid bone*. At this point there are two canals, the one above, the other below, separated by a thin plate of bone; the upper gives origin to the tensor tympani muscle, the lower is the bony part of the *Eustachian tube*, and both go to the tympanum. The cerebral surface of the petrous portion is divided by a sharp ridge, to which is attached the tentorium, into an *anterior* and *posterior surface*. On the *anterior* or *superior* surface is seen a depression for receiving the *Gasserian ganglion* of the fifth pair of nerves. Near this is a groove leading to an opening about the middle of this surface, called the *hiatus Fallopii*, which leads to the *aqueduct of Fallopius*, and transmits the superior branch of the Vidian nerve. This surface is marked by an *eminence* for the *superior semi-circular canal*, and by depressions

for the convolutions of the brain. Its superior ridge contains a groove for lodging the superior petrosal sinus.

The posterior surface has about its centre a large opening, the *meatus auditorius internus*, which gives passage to the seventh pair of nerves. It is directed outwards and somewhat forwards into a short canal, at whose termination there is a transverse ridge dividing it into two parts. The inferior is cribriform and transmits the portio mollis or auditory nerve, while the superior is a single foramen, which leads to the *aqueduct of Fallopius*, and gives passage to the portio dura or the facial nerve. This *aqueduct of Fallopius* is a long canal passing outwards and downwards behind the tympanum and terminating in the stylo-mastoid foramen. Behind the meatus internus is a small orifice, the aqueduct of the vestibule. The base or exterior margin of the petrous portion is rough, for the attachment of the cartilage of the ear, and at this point is seen the *foramen auditorium externum* which leads into the auditory canal, a tube about a half an inch long that takes a curved direction downwards, inwards, and forwards, to the membrana-tympani. This canal is composed chiefly of what is called the *auditory process*. The petrous bone also contains the organs of hearing, which will be examined in another place.

The foramina are twelve in number, 10 special and 2 common. The special are the *external* and *internal auditory*, the *stylo-mastoid*, the *mastoid*, the *carotid, glenoidal, Eustachian, Vidian, aqueductus cochleæ*, and *vestibuli*. The common are the *anterior* and *posterior foramina lacera*. The processes enumerated are six—the *styloid*, the *mastoid*, the *auditory*, the *vaginal*, the *zygomatic*, and the *jugular*. The *structure* of the temporal bone, in its squamous portion, is thin and mostly compact; the mastoid contains large cells, and the petrous is considered next in density to the teeth. Its *development* takes place by six points, viz: the squamous, mastoid, petrous, zygomatic, styloid, and auditory.

The first osseous point is seen in the squamous about the

end of the second month; very soon afterward the petrous portion begins to ossify; in the fifth month the mastoid, and the last of all the styloid.

The *squamous, mastoid*, and *petrous* portions become united during the first year. The *styloid* process is not connected with the petrous portion for several years after birth, and sometimes remains permanently separate. Occasionally it has been found to extend, by several pieces, to the hyoid bone, thus forming the hyoid arch. The *tympanic ring* becomes united to the squamous portion about the last month of fœtal life. Other changes are observed in the after development of the temporal bone, as in the growth of the mastoid cells, the extension of the meatus auditorius externus, the enlargement of the glenoid fossa, and the filling up of the irregularities of the petrous portion. At birth three pieces compose the temporal bone, viz: the squamous and zygomatic, the mastoid and petrous, and the tympanic.

Its *articulations* are with five bones. With the parietal by the superior border of the squamous; with the sphenoid by the anterior, and the occipital by the posterior border; also with the malar at the zygomatic suture, and the lower jaw in the glenoid cavity.

Ethmoid Bone.—(ἠθμος, a sieve.) The *situation* of the ethmoid bone is in the large notch between the orbitar plates of the frontal bone. It enters into the formation of the nose, the orbit of the eye, and the anterior base of the cranium. It receives its name from its cribriform or sieve-like appearance. Its *form* is cuboidal. Its *surfaces* are three, one *superior* or *cerebral*, and two *lateral* or *orbital;* there is also an *inferior*, *anterior*, and a *posterior* portion.

FIG. 42.

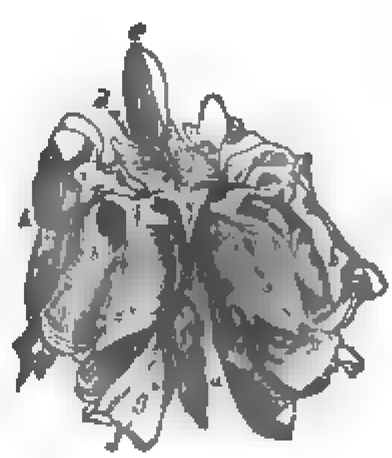


FIG. 42, Æthmoid Bone, showing an upper and posterior view. *a* Nasal lamella. *b* Cellular portion or body. *c* Crista-Galli. *d* Cribriform plate. *e* Superior meatus. *f* Superior turbinated bone. *g* Middle turbinated bone. *h* Os-planum. *i* Surface for olfactory nerve.

The *superior surface* is the *cribriform plate.* It is of an oblong shape, and perforated with many foramina for the passage of the first pair or olfactory nerves. Along the central part of this surface there is an eminence, the *crista galli*, to which the falx major is attached. On either side of this crest is a deep furrow for lodging the bulbs of the olfactory nerves; and at the anterior part of this furrow, close to the crest, is a narrow slit which gives passage to the nasal branch of the ophthalmic nerve. The crista galli, at its anterior portion, projects into two little *processes* or *alæ* which connect it with the frontal bone.

From the under surface of the cribriform plate, along the middle line, descends the *nasal lamella* or *vertical septum.* This is a broad plate of bone, thick before where it joins the nasal bones and the nasal process of the frontal bone, thick behind and above where it unites with the sphenoid, and thin below where it joins the vomer and nasal cartilage. Upon the sides of this nasal septum are seen canals ending in grooves, some oblique and others vertical, for transmitting the olfactory nerves. Upon each side of this septum is the roof of the nostril; and upon either side are also observed two irregular bones, the *superior and middle turbinated* or spongy. Next to these is a range of cells; and upon the outside of this again an external surface, smooth and plane, the *os-planum*, and forming the internal plate of the orbit of the eye. The superior and middle turbinated bones are very thin and spongy scrolls or curved laminæ of bone, the one above the other—the upper containing the superior meatus, the lower having the middle meatus, and being the more curved and the larger of the two.

The *ethmoid cells* lie between the turbinated bones and the os-planum and unguis, or between the nasal and orbital surfaces, being bounded above by the cribriform plate. They are twelve or fourteen in number, and are divided, by a bony partition, into an *anterior* and *posterior* set. The *posterior* communicate with the superior meatus, and are small, and one of the upper sometimes opens into the sphe-

noid cells. The *anterior* are more numerous and larger; they open into the middle meatus, and one of the most anterior cells forms a kind of *infundibulum* which opens above into the frontal sinus, and ends below in front of the maxillary sinus or *antrum Highmorianum*. The pituitary membrane extends from the nose, and lines the whole of the cells. Its *structure* is mostly compact, consisting of very thin brittle plates of bone; the spongy tissue is found in the *crista-galli* and turbinated

Fig. 43—A

Fig. 43—B

Fig. 43, A represents cerebral surface of the Sphenoid Bone. 1 1 Lesser wings or alæ minores. 2 2 Upper extremity of greater wings. 3 Æthmoid spine. 4 Optic foramen. 5 Anterior clinoid process. 6 Posterior clinoid. 7 Sphenoidal fissure or foramen lacerum anterius. 8 Foramen rotundum. 9 Foramen ovale. 10 Foramen spinale. 11 Styloid process. 12 External pterygoid process. 13 Internal pterygoid process. 14 Pterygoid foramen. 15 Articular surface for cuneiform process of occiput. 16 Sella turcica.

Fig. 43, B represents the anterior and inferior surface of the Sphenoid. *a a* Lesser wings of ingrassias. *b b* Greater wings. *c* Æthmoidal spine. *d* Azygos process. *e e* Sphenoidal cells. *f f* Posterior clinoid processes. *g g* Sphenoidal fissure. *h h* Foramen rotundum. *i i* Cavities for the middle lobes of the cerebrum. *j j* Surface for the temporal muscle. *k k* Styloid process. *l l* External pterygoid process. *m m* Internal pterygoid process. *n* Pterygoid foramen. *o o* Articular surface for the frontal bone. *p* Sella turcica.

portions. Its *development* takes place from three centres of ossification, one for the middle septum, and one for each lateral half. Ossification commences first in the lateral portions, about the fifth month, (seen in the os-planum first.) The middle part is not ossified till after birth, and the cells are not complete till about the fifth or sixth year. Before this period they are full, solid, and entirely cartilaginous. It is *articulated* with two bones of the cranium—the frontal and sphenoid, and 11 of the face, viz: the 2 superior maxillary, 2 lachrymal, 2 nasal, 2 palate, 2 inferior turbinated, and the vomer.

Sphenoid Bone—(σφην, a wedge.) The Sphenoid bone receives its name from the manner in which it is wedged in or surrounded by all the bones of the cranium. Its *situation* is at the base of the cranium, stretching transversely from side to side. Its *form* has been compared to the bat, to which there is some resemblance, when the ethmoid is attached. It is *divided* into a body and processes. The processes constitute the wings and feet of the bat.

The body occupies the centre of the bone, and presents upon its anterior surface the *azygos process*, which articulates with the superior end of the vomer. A small groove for vessels is seen on each side of this process. The posterior surface is flat and rough, for articulation with the cuneiform process of the occipital bone. On the superior surface there is a deep cavity called the *sella turcica.* This is perforated by foramina for the passage of vessels, and lodges the pituitary gland. It is bounded by a thin plate of bone which rises almost perpendicularly at its posterior part, and terminates in two processes called the *posterior clinoid*, to which the tentorium is attached.

At the anterior part of the *sella turcica* is an eminence called the *olivary*, where is also seen a groove marking the course of the optic nerves. The sides of the sella turcica, are grooved for the internal carotid artery.

From the superior and outer extremities of the body, proceed transversely outwards, two long and thin processes called the *alæ-minores*, the lesser wings or *apophyses*

of *Ingrassias*. These end in a point and mark the position of the fissure of Sylvius, or the division between the anterior and middle lobes of the cerebrum. These lesser wings have processes projecting backwards towards the posterior clinoid, and sometimes uniting with them, called the *anterior clinoid* processes. These are thick tubercles, and have in their base a large foramen for transmitting the optic nerve and ophthalmic artery.

From the posterior and inferior part of the sides of the body, proceed outwards, upwards, and forwards, the *alæ majores* or greater wings. These processes present three surfaces, an *anterior* or *orbital*, an *external* or *temporal*, and an *internal* or *cerebral*. The *orbital surface* or *process*, assists in forming the outer wall of the orbit, is smooth and somewhat square. The *temporal surface* or process is divided by a transverse ridge, called the *crest*, into two portions, that above the crest helping to form the *temporal fossa*, that below entering into the formation of the *zygomatic fossa*. The *inner* or *cerebral surface* is concave, and with the temporal bone, receives the middle lobe of the cerebrum.

From the junction of the greater wings with the body, descend the *pterygoid processes*. Each process is divided into an *external* and an *internal plate*. The *external plate* has the pterygoideus externus muscle attached to its outer side, and the pterygoideus internus to its inner side. The *internal plate* ends in a curved hook-like process, called the *hamular process*, is covered by a bursa, and over it the tendon of the circumflexus palati muscle plays. Between the two plates is the *pterygoid-fossa*, occupied by the Eustachian tube, and the tensor palati muscle. The space between the two pterygoid plates at their lower extremity, is filled by the pterygoid process of the palatine bone. Through the base of the pterygoid process runs the *Vidian canal*, which gives passage to the pterygoid branch of the fifth pair of nerves.

The angle between the squamous and petrous portions of the temporal bone is occupied by a process called the *spinous*, which projects from the posterior part of each wing,

curving downwards and outwards. To it are attached the internal lateral ligament of the lower jaw, the laxator tympani, and the tensor or circumflexus palati muscles.

This bone has a number of foramina. Beginning in front and proceeding backwards, we observe, first, at the root of the lesser wings, the *foramen opticum* for the optic or nerves of sight; second, the *foramen rotundum*, in the base of the greater wing, where it joins the body. This opens into the pterygo-maxillary fossa, and transmits the superior maxillary nerve. Behind it, about half an inch, is the *foramen ovale*, which gives passage to the inferior maxillary nerve; and a little posterior to this again is a small opening, the *foramen spinale*, through which passes the middle meningeal artery. Between the lesser and greater wings is a long slit, the *foramen lacerum superius* or *orbitale*, wide internally, narrow externally, and transmitting the third, the fourth, the first branch of the fifth, and the sixth pair of nerves, together with several filaments of the sympathetic nerve and the ophthalmic vein. Between the posterior part of the greater wing and the petrous portion of the temporal bone there is another slit, the *foramen lacerum medius;* and at the base of the pterygoid process, as stated, the *Vidian foramen.*

The *structure* of the sphenoid is cellular in the body and bases of the processes, compact every where else. At about the age of ten years the body is hollowed into cavities called the *sphenoidal sinuses.* In front of them are two triangular pyramidal bones, called, after their discoverer, the *ossa pyramidalia Wisterii*, or the *sphenoidal turbinated bones.* The base of each of these is anterior, and connects with the ethmoidal bone and its cells; the apex is posterior, and unites with the sphenoidal sinuses. These pyramids of Wistar are found to be fused into the body of the sphenoid from about the fifteenth to the eighteenth year.

The *development* of this bone has been noticed to begin from as many as twelve points of ossification, viz: 4 for the body, 4 for the wings, 2 for the pterygoid processes, and 2 for the pyramids of Wistar. At birth the sphenoid is seen

to consist of three pieces, viz: 1 and 2, the greater wings and pterygoid processes of either side, and 3, the lesser wings and body in a single piece. The sphenoidal spongy bones, or pyramids of Wistar, belong also to the latter piece. Ossification is noticed in the various parts in the following order, viz: 1. In the greater wing and external pterygoid process, about the seventh or eighth week. 2. Lesser wings and posterior body, at the close of the second month. 3. Anterior body, at the end of the third month. 4. The internal pterygoid plate has a separate ossific point, which is stated to unite with the external pterygoid about the middle of the fourth month. The centres for the posterior portion of the body, and those for the anterior and lesser wings, are seen to unite first; then the greater wings and pterygoid processes. The latter unite with the body during the first year; the pyramids of Wistar join it about puberty, at which time this bone becomes connected with the ethmoid; while the body of the sphenoid joins the occipital bone between the eighteenth and twenty-fifth years.

The *sphenoid* is *articulated* with all the bones of the cranium and five of the face, viz: the two malar, two palati, and the vomer.

GENERAL REMARKS ON THE CRANIUM.

Under the head of the osseous tissue the different articulations were described. *Synarthrosis* was stated to denote the articulation of bones that have no motion, and *suture* the mode of union between the different bones of the cranium.

The *coronal*, the *sagittal*, the *lambdoid*, the *squamous*, the *sphenoid*, and *ethmoid*, constitute the principal sutures. (See Fig. 53.)

The *coronal* suture connects the anterior edges of the parietal bones with the superior margin of the frontal, and extends from side to side over the superior and anterior surface of the cranium.

The *sagittal* unites the parietal bones along the median line, and extends, from the superior angle of the occipital

bone forwards, to the centre of the coronal suture. The two extremities of this suture occupy the place of the anterior and posterior fontanelles.

The *lambdoidal* connects the posterior edges of the parietal with the superior margin of the occipital bone, and extends from the posterior end of the sagittal suture, on either side, to the mastoid process of the temporal bone. An extension of this suture, under the name of the *additamentum suturæ lambdoidalis*, reaches as far down as the *foramen lacerum posterius*, passing between the mastoid and petrous portions of the temporal and the occipital bones. In this suture we find the ossa triquetra or wormiana.

The *sphenoid suture* is as extensive as the very irregular edge of the sphenoid bone, connecting with it the ethmoid, frontal, parietal, temporal, and occipital bones of the cranium.

The *ethmoid* suture in the same way surrounds the ethmoid bone, uniting it with the frontal and other bones.

The *diameters* of the cranium are thus given by Bichat: The *antero-posterior* is about five inches, and extends from the foramen cœcum in front, to the internal occipital protuberance behind. The *transverse diameter* is four inches and a half, and extends between the bases of the petrous portions of the temporal bones. The *vertical diameter* is somewhat less than the transverse, and reaches from the middle of the sagittal suture to the anterior edge of the foramen magnum.

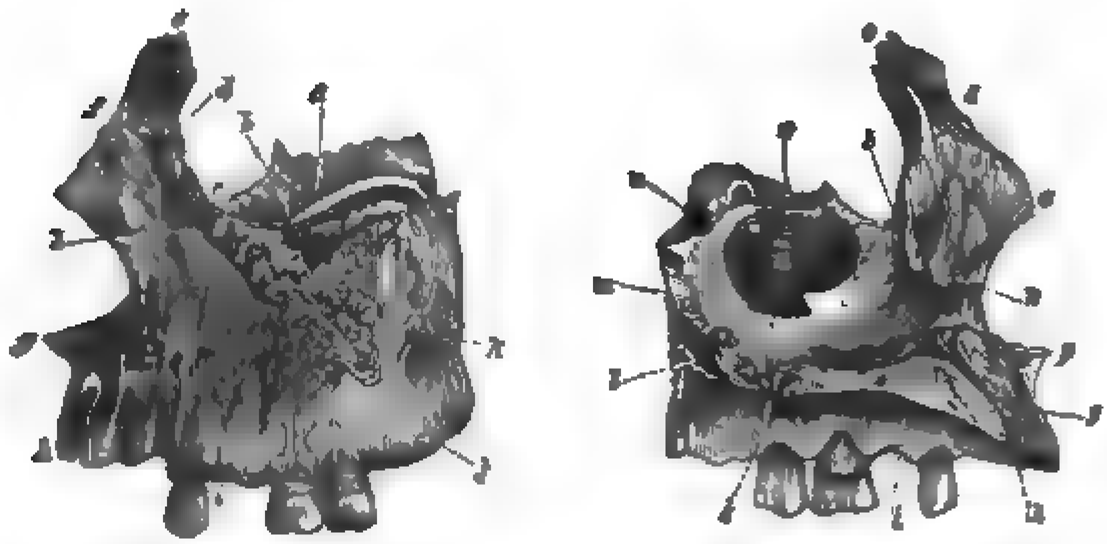
SECTION II.

BONES OF THE FACE.

The Superior Maxillary Bones—(*ossa maxillaria superiora.*) The superior maxillary is the principal and largest bone of the face. It enters into the formation of the orbit, the nose, the mouth, and the palate. It is *situated* so as to form the greater part of the front of the face. Its *shape* is somewhat triangular, though very irregular. The two taken together are symmetrical, each lateral portion com-

ing in contact upon the median line. It is *divided* into *body* and *processes*. The body presents five *surfaces* for examination. 1, the *anterior or facial*; 2, the *internal or*

A Fig. 44. B



nasal; 3, the *superior or orbital*; 4, the *inferior or palatine*; 5, the *posterior or zygomatic*.

The *anterior surface* is concave, and called the *canine fossa*. At the upper part of this fossa is the infra-orbital foramen, for transmitting the infraorbital vessels and nerve. From the upper and inner part of this fossa the *nasal process* of the superior maxilla arises. It ascends and forms the side of the nose. Its superior edge is serrated and articulates with the frontal bone. Its anterior edge is smooth and unites with the nasal bone and the

Fig. 44, A represents an outer view of the superior maxilla of the left side. *a* Orbitar process. *b* Infra-orbitar canal. *c* Situation of the os-unguis. *d* Superior portion of lachrymal canal. *e* Articulating surface for frontal bone. *f* Articulating portion with nasal bone. *g* Anterior part of the floor of the nostril. *h* Point of articulation with its fellow. *i* Alveolar process. *j* Canine fossa. *k* Articulating surface for the malar bone.

Fig. 44, B represents an inner view of the superior maxilla of the left side. *a* Maxillary sinus or Antrum of Highmore. *b* Ductus ad nasum. *c* Articular point for the frontal bone. *d* Articular edge for the nasal bone. *e* Surface for the nasal cartilage. *f* Anterior point of the floor of the nostril. *g* Articulating surface for the bone of the right side. *h* Foramen incisivum. *i* Palatine process. *j* Articulating edge for the palate bone. *k* Anterior articulating ridge for inferior turbinated bone. *l* Articular surface for the palate bone behind. *m* Surface for the nasal portion of the palate bone. *n* Surface for the orbitar plate of the palate bone. *o* Termination of nasal duct.

alar cartilage. The posterior is round, and forms the inner border of the orbit, and immediately posterior to this border is a deep *groove*, the *lachrymal fossa*, for the nasal duct. Its anterior surface has the *orbicularis palpebarum* and *levator labii superioris alæque nasi* muscles attached to it. Its internal surface forms part of the nares. The canine fossa is bounded externally by a rough, serrated surface, the *malar process*, which is concave and smooth behind for receiving the temporal muscle.

From between the nasal and malar processes, and projecting backwards, so as to form the floor of the orbit, is the *superior* or *orbital surface* or *process*. This surface has a triangular form; its base is internal and connected with the unguiform, ethmoid, and palate bones. Its *posterior border* helps to form the *spheno-maxillary fissure*. Its *external* unites with the malar bone, and its middle surface is channeled into a canal, the *infra-orbital canal*, which terminates in the *infra-orbital foramen*. This process is a very thin plate of bone forming the roof of the antrum as well as the floor of the orbit. The infra orbital canal, at its anterior part, divides into a smaller canal, the *anterior dental*, which descends in the anterior wall of the antrum to the anterior alveoli.

The *posterior surface* of the superior maxillary bone is posterior and below the orbital. Its most prominent feature is the *tuberosity*, which is larger in the young subject, as it then contains the last molar tooth, and has three or four small foramina, called the *posterior dental canals*, which lead to the posterior alveoli, and transmit to the molar teeth the posterior dental nerves and arteries. The inferior portion of the tuberosity presents a rough surface for articulation with the palate bone, and above and to the inner side of this point of articulation, is a smooth canal, which forms a portion of the *posterior palatine canal*.

The *inferior* or *palatine surface* of the upper jaw constitutes the floor of the nostrils and the roof of the mouth, which corresponds in situation to the inter-maxillary bones of inferior animals.

To the practical dentist, Mr. Nasmyth uses the following strong language in reference to these bones: "These bones serve most importantly to render the upper jaw pliant during the actions of the mouth in the early years of life, and they are also of high account in promoting by their growth the latitude necessary for the proper arrangement of the teeth. As a means also of preventing concussion of the teeth, they are valuable accessories in the mechanism of the mouth." He thus describes their anatomy: "In the fœtal skull, at the point of junction of the posterior with the middle third of the foramen incisivum, a fissure may be observed, which passes upwards into the anterior palatine canal on each side, and may be traced onwards to the floor of the nasal cavity. Having reached the latter situation, it inclines obliquely backwards and outwards for the distance of about a line, and then bends forwards and upwards for a space of two or three lines to the base of the nasal process of the superior maxillary bone, terminating upon the latter at one or two lines below the ridge for the inferior turbinated bone. If the foramen incisivum be again examined, another fissure will be observed on the oral surface of the palate, passing directly outwards to the alveolus of the canine tooth, and curving gently backwards in its course. The portion of bone which lies anterior to these fissures on each side, and which supports the incisor teeth, is the *inter-maxillary* bone."*

This surface is also called the palatine process of the superior maxillary bone. It is smooth and concave above, where it forms the nares, and rough below where it forms the mouth. Its anterior boundary is very thick, and constitutes the *alveolar arch* and *processes.*

This arch has eight conical cavities for the teeth, and when united with its fellow, completes the circle and contains sixteen in all. The cavities are separated by partitions of dense cellular tissue, and have their *shape* corresponding to the variety of teeth they accommodate. The walls of these cavities form the alveolar processes. The

* Nasmyth's late Researches.

alveolus of the *central incisor* has, according to Mr. Nasmyth, the septum between it and its fellow twice as thick as that of the other teeth; its antero-posterior diameter one-third greater than at the sides, and its lateral diameter one third greater in front than behind. Its anterior wall is so thin as to be sometimes incomplete.

The *alveolus* of the *lateral incisor* has less depth than the central, its septum between the latter is not so thick as between it and the canine, its posterior wall is thicker than the anterior, and its antero-posterior diameter is greater than the lateral.

The *alveolus of the canine* ascends above the level of the roof of the mouth, and is the deepest of all the alveoli; it corresponds to the anterior wall of the maxillary sinus, is of oval form as the incisors, and has its antero-posterior diameter about one tenth greater than the latter, and looking backwards.

The alveolus of the first bicuspid has its inferior part partitioned into two cavities for the roots, the external being the larger, while its middle is found narrowed. Its depth is equal to the second bicuspid, but not so great as the canine, and the septum between it and the latter is not so great as that separating it from the second bicuspis.

The alveolus of the second bicuspis is not narrowed in its middle as the latter, nor divided by a middle septum into cavities, and its form is oval.

The alveolus of the first molar is divided into three cavities, two of which are external, the other internal; the internal is the largest, and the posterior external the smallest, hence a rule of practice for entering the antrum, founded upon the size and direction of these cavities, always is to select the internal or anterior external cavity for this purpose; the internal cavity occasionally looks to a division of itself, and is sometimes found to communicate with the posterior, in which case only one root, strong and broad, is seen instead of two. This alveolus is not unfrequently found to open into the antrum, on which account it is regarded as the most suitable one for perforating the antrum of High-

more, as well as presenting the most dependent position of this sinus, though the antrum may be entered from the alveolus of either the second or first bicuspis, but the direction would have to be obliquely backwards.

The alveoli of all the molar teeth present the triple division for its roots, which latter sometimes very much diverge, and then again, on the contrary, greatly converge, so much as sometimes to present the appearance of a single root. Either too great divergence or convergence of the roots offers difficulties to extraction, and especially so when a portion of the alveolus is embraced.

The posterior edge of the palatine process is thin and serrated to join the palate bone—internally it is thick where it unites with its fellow—and at the anterior part of this union is the *anterior palatine canal*, which opens superiorly into the nostrils by two foramina, and inferiorly on the mouth by one, the *foramen incisivum*.

At the place of junction of the palatine processes, the upper edge in the nares is raised, and called the *nasal crest*, which receives the inferior border of the vomer. This crest projects forwards and forms the nasal spine, between which and the nasal process, the bone is rounded and concave, forming the anterior nares.

The internal or nasal surface.—The nasal surface presents a very large opening situated between the middle and lower turbinated bones, and leading into a cavity called the *antrum Highmorianum*, or maxillary sinus. This sinus is of a triangular or pyramidal shape, the base looking to the nose, the apex to the malar process. It is bounded above by the orbitar process of the superior maxillary bone, forming its roof, below by that portion of the alveolar arch corresponding to the first and second molar teeth, constituting the floor; in front by the canine fossa, and behind by the tuberosity. Its shape and size vary much in different bones. It is lined by the pituitary membrane of the nose. Its opening in the natural skeleton is much contracted by the ethmoid and lachrymal bones above and in front, by the inferior spongy below, and the palate bone behind. This

opening, says Mr. Nasmyth, "presents much variety, both in direction and position, sometimes looking obliquely forwards, at others obliquely backwards, and being sometimes in the anterior and sometimes in the posterior portion of the nasal process." It is stated to be about the diameter of a crow quill, and when deprived of the soft parts, to measure from thirty to forty lines in circumference. The mucous membrane also diminishes the opening. The antrum has its cavity sometimes divided by septa into cells. Its roof has the infra-orbital canal running along it, and terminating in the infra-orbital foramen. This roof is very thin, and readily allows tumors of the antrum to project into the orbit. The floor has but a thin partition between the roots of the teeth and this cavity, so thin indeed in some cases, that the apices of the molar teeth are seen to project into the sinus, and hence this is here regarded as the most eligible spot for puncturing the antrum, and drawing off any purulent collections it may contain. By some, the alveolus of the canine tooth is thought most convenient for entering the maxillary sinus.

The anterior and posterior walls of this sinus contain the anterior and posterior dental canals, for transmitting the dental nerves and vessels. The opening of the antrum communicates, by one or two small oblique orifices, with the middle meatus of the nose, and anterior to it is the funnel-shape tube, the *infundibulum*, connecting with the frontal sinus and anterior ethmoid cells.

The foramina in each superior maxillary bone are six in number—2 proper and 4 common. The proper are the *infra-orbital* and *foramen incisivum.* The common are the *foramen* of the *antrum*, the *posterior palatine*, the *anterior nares*, the opening into the *nasal* or *lachrymal duct*, and the *spheno-maxillary fissure.*

The number of processes is eight, viz: the orbital, nasal, the tuberosity, the alveolar, malar, palatine, the nasal spine, and the nasal crest.

The *structure* of the upper maxillary is thick and cellular in its processes, and very thin, but compact about the

antrum, and, though the largest of all the bones of the face, is nevertheless exceedingly light, on account of the great size of the antrum.

Its *development* is not agreed on among anatomists. Six centres of ossification are enumerated, viz: one for the body and one for each of the processes, nasal, malar and palate, and two for the alveoli. Ossification, however, begins very early, about the end of the first or beginning of the second month of fœtal life, in the alveolar arch. The anterior palatine portion remains distinct for two or three years, and is called the *os-incisivum* or inter-maxillary, and represents the permanent condition in some of the inferior animals. At birth this bone has great transverse breadth, but little height, owing to the floor of the orbit and the alveolar arch coming so close together, which is, however, gradually remedied by the enlargement of the antrum or maxillary sinus.

Its *articulations* are with two of the cranium, the frontal and ethmoid, and seven of the face, viz: the palate, the malar, nasal, lachrymal, inferior turbinated, vomer and its fellow.

Palate Bones—(*ossa palati.*) The *situation* of the palate bones is at the posterior part of the nares. They contribute to form the floor of the orbit, the side of the nose, and the palate. They are symmetrical. The *form* is irregular, though it has

A FIG. 45. B

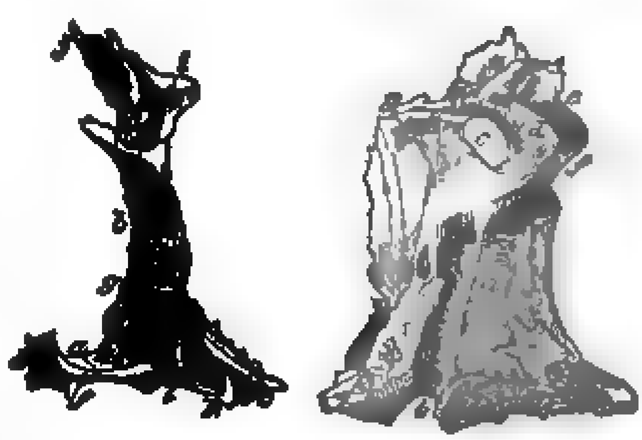


FIG. 45, A represents a posterior view of the Palate Bone. *a* Nasal surface of horizontal plate. *b* Nasal surface of ascending plate. *d* Articulating border for its fellow. *c*, *k*, *l* Pterygoid process. *f* Process formed by junction with its fellow. *g* Horizontal articulating ridge for inferior turbinated bone. *h* Spheno palatine foramen. *i* Orbital process. *j* Sphenoidal process.

FIG. 45, B represents ascending plate of Palate Bone, on its spheno-maxillary surface. *a* Articulating surface with supericr maxillary bone. *b* Posterior palatine canal. *c* Spheno-palatine foramen. *d* Spheno-maxillary face. *e* Orbital face. *f* Maxillary face. *g* Sphenoidal process. *h* Pterygoid process.

some resemblance to the letter L. The palate bone is divided into two portions, the *horizontal* or *palatine* and the *vertical* or *nasal* portion. The *horizontal* portion is quadrilateral, and forms the posterior part of the hard palate. Its upper surface is concave from side to side, and forms the posterior nares, and where it unites with its fellow there is a *crest* to connect with the vomer. This crest continues backwards into a projecting process, constituting the *posterior nasal spine*, to which the azygos uvulæ muscle is attached. The lower surface of the horizontal plate is rough and completes the arch of the palate. Its anterior edge is serrated obliquely and rests upon the palatine process of the superior maxillary. Its posterior edge is thin and concave and gives attachment to the velum palati.

The *vertical* or *nasal* plate rises perpendicularly from the horizontal, and is thin and broad; it presents two surfaces, an external and internal, and two edges, an anterior and posterior. The external surface is uneven and rough in front where it unites with the superior maxillary. It is grooved into a canal—the *posterior palatine canal*—for the passage of the palatine vessels and nerves. This canal is bounded in front by the tuberosity. The *inner* or *nasal surface* is divided by a transverse ridge to which the inferior turbinated bone is articulated. This ridge has a depression above and below it; the upper corresponds to the middle meatus, the lower to the inferior meatus of the nose. At the point of junction of the nasal with the horizontal plate is the *pterygoid process* or *tuberosity*. It is thick, and wedge-shaped, and occupies the space at the lower part, and between the two plates of the pterygoid processes of the sphenoid bone. It presents three surfaces, two lateral uniting with the pterygoid plates, and one posterior and concave forming part of the pterygoid fossa. One or two small foramina perforate this process from the palatine canal. At the superior extremity of the nasal plate are seen two processes, the *orbital* and *sphenoidal*. The orbital is anterior and the larger of the two; it is triangular and is situated in the most posterior part of the floor of the orbit,

and is united by its internal edge to the ethmoid, by its anterior edge to the superior maxillary, and by its posterior to the sphenoid bone. The sphenoidal process is smaller, and posterior to the orbital. Its external lateral surface assists in forming the spheno-maxillary fossa; its internal helps to form the nares, and its superior articulates with the sphenoid bone. Both of these processes are cellular and communicate with the cells of the sphenoid and ethmoid. They are separated by a large opening, the *spheno-palatine foramen*, which gives passage to the *spheno-palatine nerve* and artery.

The *palate bone* has four foramina, one proper and three common. The posterior palatine is the proper, and the spheno-palatine, the pterygo-maxillary canal, and the spheno-maxillary fissure are the common.

Its processes are seven in number, the nasal, palate, pterygoid, orbital, sphenoidal, posterior nasal spine and crest. Its *structure* is mostly compact and thin, except in the processes. Its *development* is by a single centre of ossification, about the middle of the second month, at the point of union of the horizontal and vertical plates. It is *articulated* with the sphenoid and ethmoid of the cranium, and with four of the face, the superior maxillary, vomer, inferior turbinated, and its fellow.

Malar Bones—(*ossa-malarum.*) The malar or cheek bones are in pairs, and occupy a prominent *situation* on each side of the face, at the outer and under portion of the orbit. Their *form* is quadrilateral. The external surface of each is convex, and has one or more small foramina for the passage of vessels and nerves, and also has the orbicularis palpebrarum covering it. From the upper part of this bone ascends the *superior* or *external orbital process* to join the frontal bone. From its inner portion

FIG. 46.

FIG. 46 represents an internal view of the right Malar Bone. *a* Superior or external orbital process to join the frontal bone. *b* Orbitar process. *c* Malar foramina. *d* Maxillary process. *e* Lower edge of the malar bone. *f* Zygomatic process. *g* Posterior concave surface. *h* External edge.

is the *maxillary process* which articulates with the maxillary bone.

From between these two processes the bone is smooth and round, and forms about one third of the lower and outer margin of the orbit. From this margin there projects backwards into the cavity a thin plate of bone called the *internal orbital process.* This process joins the sphenoid and superior maxillary bones, and is notched posteriorly where it bounds in front the spheno-maxillary fissure. The lower margin of the cheek bone has the masseter muscle attached, and from its posterior end proceeds the *zygomatic process*, upon which rests a similar process from the temporal bone. The internal or posterior surface is concave and smooth, and forms part of the temporal fossa. The *structure* is thick and cellular, having a delicate compact covering.

The *development* is from a single point of ossification, commencing about the latter part of the second month. It is *articulated* with four bones, i. e. frontal, sphenoid, temporal, and superior maxillary.

Lachrymal or Unguiform Bones, (*ossa-unguis.*) The *lachrymal* or *tear bones* are two in number, and *situated* at the anterior and inner portion of the orbit. Their *form* is oval, and present an outer or orbital surface, which is smooth and forms a portion of the inner orbit. At the anterior part of this surface is a vertical ridge, within which is a deep groove, to unite with a corresponding one in the posterior part of the nasal process of the superior maxillary, constituting the upper portion of the nasal duct and lodging the lachrymal sac. The internal or nasal surface is rough and covers the anterior ethmoid cells.

A. FIG. 47. B.

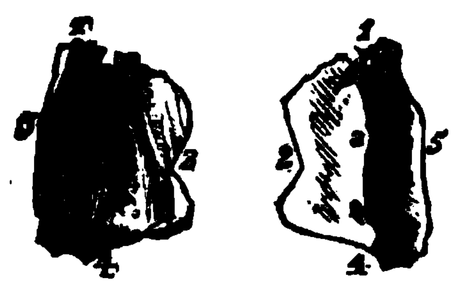


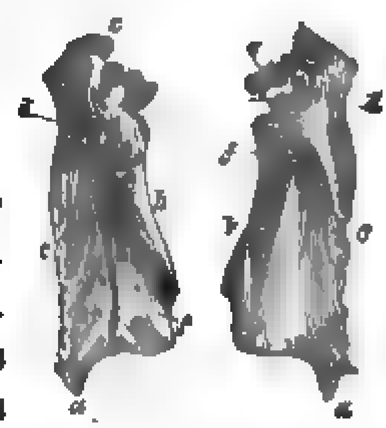
FIG. 47, A represents right side of os-unguis or Lachrymal Bone, upon the orbitar or outer aspect. 1 Upper margin. 2 Posterior margin. 3 Vertical ridge. 4 Inferior margin. 5 Anterior margin.

FIG. 47, B represents the inner aspect of the same bone. 1 2 4 5 Show the same points as in A. The vertical groove is seen in this figure.

The *structure* of these bones is entirely compact, very thin, transparent, and among the most brittle of all the bones. The *development* of each bone is by a single point of ossification, which is said to be completed at the beginning of the third month. The *articulations* are with four bones, i. e. two of the cranium and two of the face. By its superior and posterior edges it is united to the frontal and ethmoid, and by its inferior and anterior edges to the superior maxillary and lower turbinated bone.

Nasal Bones—(*ossa-nasi.*) The bones of the nose are *situated* between the nasal processes of the superior maxillary, and below the frontal. They are two in number, and meet along the median line, so as to form an arch called the bridge of the nose. This arch is thick and narrow above, where it joins the frontal bone, and thin and expanded below where it connects with the cartilage. The external *surface* is convex and covered by the pyramidalis and compressor nasi muscles. The internal surface is concave and receives the nasal branch of the ophthalmic nerve.

A. FIG. 48. B.



The *structure* of the nasal bones consists of two compact tables, with intervening diploe. Their *development* takes place by a single point of ossification about the end of the second month. The *articulation* is with four bones, i. e. the frontal and ethmoidal of the cranium, and the superior maxillary and its fellow of the face.

Inferior Turbinated Bones — (*ossa turbinata inferiora.*) (Fig. 49.) The inferior turbinated or spongy bones are *situated* at the lower and outer part of the nares. Their

FIG. 48, B represents an anterior view of the nasal bones. *a* Inferior extremity. *b* Articulating surface for its fellow. *c* Articulating edge for the superior maxillary bone. *d* Groove on inner side for nasal nerve. *e* Articulating border for frontal bone. *f* Foramen for nutritious artery.

FIG. 48, A represents a posterior view of nasal bones. *a* Inferior extremity *b* Articulating margin for its fellow. *c* Articulating margin for superior maxilla. *d* Groove for internal nasal nerve. *e* Articular border for frontal bone. *f* Lower portion of groove for the nasal nerve.

greater length extends from before backwards. They are two in number and have an *irregular form*. Each presents two surfaces, an internal or convex, and external or concave. The superior edge is united to the maxillary and palate bones by their transverse ridges, and from it ascends a small pyramidal process connecting with the unguis to complete the nasal duct. The inferior edge is free and rolled outwards. The anterior point forms the inner wall of the lower orifice of the nasal duct. The *structure* is thin, brittle, and filled with small pores. The *development* is by a single point from the centre, commencing about the fifth month of fœtal life. The *articulations* are with four bones, the superior maxillary, the lachrymal, the ethmoid and palate.

FIG. 49.

Vomer—(*the plough-share.*) The vomer, a single bone, so called from its supposed resemblance to the plough-share, or, more properly, the coulter of the plough, is *situated* on the median line so as to divide the nares. It has two surfaces, which are lateral, and covered by the pituitary membrane, and four edges, a superior, an inferior, an anterior, and a posterior. The superior is thick and hollow, and receives the azygos process of the sphenoid bone. The inferior is long and united to the palatine crest of the superior maxillary and palate bones. The anterior edge is grooved to receive the middle septum of the ethmoid bone and nasal cartilage; while the posterior is sharp and divides the nares behind. Its *structure* is compact, thin, and transparent. Its *development* is from a single point, commencing about the end of the second month, at its lower portion. Its *articulation* is with

FIG. 50.

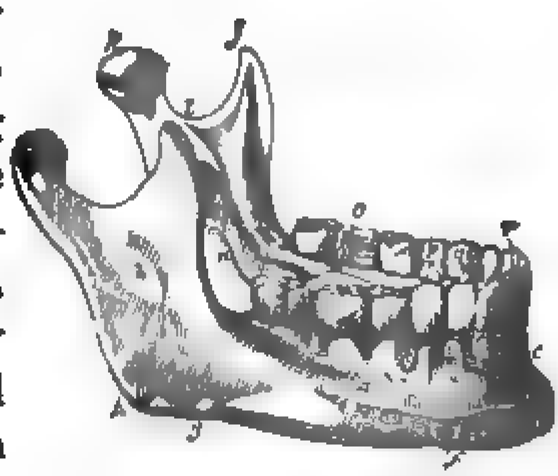
FIG. 49 represents the maxillary or outer aspect of the right Turbinated Bone. 1 2 Posterior and anterior angles of the turbinated bone. 3 Lachrymal process. 4 Maxillary process. 5 Lower margin. 7 Curved portion of the maxillary process.

FIG. 50 represents the vomer in profile. 1 2 Superior edge, 3 Anterior edge, 4 Inferior edge of vomer. 6 Lateral surface.

six bones, i. e. the sphenoid, ethmoid, two upper maxillary, and two palate.

Inferior Maxillary Bone—(*os maxillare inferius*.)—The *inferior maxilla*, or lower jaw, is *situated* at the lower part of the face, occupying the front and sides, and extending as far back as the base of the skull. Its *form* is semi-circular, and consists of a *body* and two *extremities*. The body forms the central and lateral portions. The central portion is prominent, known as the chin, and has a vertical ridge along its median line, the *symphysis menti*, which denotes the original separation of this bone into two symmetrical parts.

Fig. 51.



The anterior surface of the chin often presents a triangular shape, the base below having, at either end, a prominent process, while the apex is above. On either side of the symphysis is a depression for the origin of the *depressor labii inferioris* muscle; and external to this is an oblique opening, the *anterior mental foramen*, through which come out the inferior dental nerve and artery. On the posterior part of the chin the surface is concave, except in the middle line of the symphysis, where is seen a chain of eminences. To the upper one of these is attached the *frenum linguæ*, to the middle, the *genio-hyoglossi*, and to the lower, the *genio-hyoidei* muscles. On either side of this middle line, and at the upper part, are two depressions for the sublingual glands, and, at the lower part likewise, depressions for the digastric muscles. The lateral portions take a direction outwards and backwards; on their exter-

Fig. 51 represents the inferior Maxillary Bone. *a* Body; *b* Ramus; *c* Symphysis menti; *d* Alveolar process; *e* Anterior mental foramen; *f* Base; *g* Groove for the facial artery; *h* Angle; *i* Posterior portion of ridge for the mylo-hyoid muscle; *j* Coronoid process; *k* Condyle; *l* Neck of Condyloid process; *m* Posterior mental foramen; *n* Groove for inferior maxillary nerve; *o* Molar teeth; *p* Bicuspid teeth; *q r* Middle and lateral incisors.

nal surface is an oblique ridge running backwards and upwards to the root of the coronoid process, to which is attached the *depressor-anguli oris* and *platzsma* in front, and the *masseter* muscle behind.

On the internal surface is also an oblique ridge, called the *mylo-hyoid ridge*, which gives attachment to the *mylo-hyoid* muscle in front, and the *superior constrictor* of the *pharynx* and intermaxillary ligament behind. Beneath this ridge is a groove for the mylo-hyoid nerve, and below this an oblong depression for the sub-maxillary gland. The lower border of the jaw, called the base, is thick and rounded. The upper border is the alveolar arch, having its *alveolar processes* and cavities corresponding to the variety of teeth they receive. The *alveolar cavity* of the *middle incisor* has its antero-posterior diameter the broadest, and the septum between it and its fellow thicker than that separating it from the lateral. The *alveolus* of the *lateral incisor* has its opening wider in front than behind, and is described as being indented on its outer side. Its anterior wall is a little convex, the posterior concave, and its lateral septa thicker behind than in front.

The *alveolus* of the *canine* is found to be larger than that of either the incisors or bicuspids. Its form is conical, with the sides compressed and presenting, laterally, a depression corresponding to the root of the tooth. Its anterior wall is said to be more prominent and thinner than any other in the dental arch, and looks backwards and downwards, while the posterior is directly vertical. The axis of the canine is forwards and upwards, and the opening of its alveolus is said to be twice the breadth in front that it is behind. Its form is oval.

The *alveolus* of the *first bicuspid* has its form conical, its sides compressed, its outer surface flat, and its inner rather concave. It is smaller than the canine, has its opening oval, with edges in front and behind seen to be a little indented. Its antero-posterior diameter looks outwards and forwards, its vertical obliquely inwards.

The *alveolus* of the *second bicuspid* has its vertical axis look-

ing, says Mr. Nasmyth, downwards and backwards; a fact which he regards of great practical moment in the management of the teeth, as a space is thus gained of three or four lines between the roots of the two bicuspids. This alveolus is larger than that of the anterior, but less than that of the canine.

The *alveolus* of the *first molar* has a partition dividing it into an anterior and posterior cavity—the anterior being rather the larger, and the axes of both looking backwards. The septum is described as thickest in the centre, abounding with openings for the passage of vessels, and has its direction inwards and backwards from the outer side. Its opening is of a quadrilateral form, having its front margin indented.

The *alveolus* of the *second molar* has also a septum (occasionally absent) dividing it into an anterior and posterior cavity, the anterior being the larger, and found to be somewhat contracted in its middle and "compressed from before backwards;" the posterior is oval and not so deep. Its opening is also quadrilateral.

The *alveolus* of the *third molar* is always smaller and shallower than either of the others, and is found to present great variety both in form and size. It is seen sometimes divided into two cavities, and then again having but one. The alveoli of the molar teeth all look outwards, so that the crowns of these teeth have a direction inwards.* At the posterior extremity of the lateral portions is the *angle*, which is nearly a right angle in the adult, but quite obtuse in the fœtus, and to which, on its internal edge, is attached the *stylo maxillary* ligament. From the posterior ends of the lower jaw there rises, almost perpendicularly, a process called the *ramus*. This process is square-shaped and very strong. It has different angles at different periods of life. In the infant it is nearly on a line with the lateral portions. In youth it is oblique. In the adult it becomes nearly vertical, while in old age it again returns to the infant state Its external surface is covered by the masseter muscle

* Alexander Nasmyth's late Researches on the Teeth.

Its internal surface has, in the centre, the *posterior mental* or *inferior dental foramen*, which transmits the inferior dental artery and nerve. This foramen is protected by a shelf of bone to which is attached the internal lateral ligament, and it leads to a canal which passes beneath the alveolar cavities, with each of which it communicates, and conducts to the teeth their nerves and vessels. Below this posterior foramen is the insertion of the *pterygoideus internus* muscle. The ramus terminates above in two processes, viz: the anterior or *coronoid*, and posterior or *condyloid*.

The *coronoid* process is triangular and is surrounded by the tendinous insertion of the temporal muscle. The anterior border of the root is grooved for the *buccinator muscle*. The *condyloid process* is oblong and has its greatest diameter looking obliquely backwards and inwards. Its upper surface is smooth and covered with a movable fibro-cartilage, intervening between it and the glenoid cavity of the temporal bone with which it articulates. Around the base of the condyle there is a contraction called its *neck*, to the anterior and inner portion of which the pterygoideus externus muscle is inserted. The curve between the two processes is the *sigmoid notch*, over which pass the masseteric artery and nerve.

The *structure* of the lower jaw is compact externally, and spongy or cellular within. The walls of the alveoli and their partitions are also spongy. The interior of this bone has already been stated to be traversed by the inferior maxillary or dental canal. This canal, commencing at the posterior dental foramen, gradually contracts as it proceeds forwards under the summits of the alveoli. At the second bicuspid tooth it divides into two canals, the one large, terminating at the anterior mental foramen, the other small and continued forward in the line of the original canal, to the incisor teeth, to which it is distributed.

The *situation* of this canal varies at different periods of life. In the infant, at birth, according to *Cruveilhier*, it occupies the lowest portion of the jaw. After second den-

tition, it is nearly on a line with the mylo-hyoid ridge; and in old age, when the teeth are lost, it runs along the alveolar border. Its size also varies. Before the appearance of the second teeth, and in the fœtus, it is observed to be very large; it diminishes in the adult, and contracts still more in old age.

The *development* of the inferior maxilla is by two points of ossification, one for each lateral half; their common point of union being the symphysis. It and the clavicle are the first bones formed. The lower edge of this bone is seen to commence ossifying about the end of the first month, and about the end of the second, each half of the bone presents a groove common to the dental canal and alveoli. Union of the symphysis occurs during the first year.

ARTICULATION OF THE LOWER JAW.

It *articulates* with the temporal bones at the glenoid fossæ, and with the sixteen lower teeth. The *condyles* of the inferior maxilla and that portion of the glenoid cavity of the

A FIG. 52. B

temporal bone, in front of the glasserian fissure, constitute the bony portions which enter into the movable articulation

FIG. 52, A represents an external view of the Articulation of the Lower Jaw. *a* Zygomatic arch. *b* Tubercle of the zygoma. *c* Ramus of the lower jaw. *d* Mastoid process of the temporal bone. *e* External lateral ligament. *f* Stylo-maxillary ligament.

FIG. 52, B represents an inner view of the same articulation. *a* Section through the petrous portion of the temporal bone and spinous process of the sphenoid. *b* Internal view of part of the body and ramus of the lower jaw. *c* Internal portion of the capsular ligament. *d* Internal lateral ligament. *e* Point for passage of the mylo-hyoid nerve. *f* Stylo-maxillary ligament.

of the lower jaw, and which are covered with cartilage. The other elements of this joint consist of,

1. A capsular ligament,
2. External and internal lateral ligaments,
3. Interarticular cartilage,
4. Two synovial membranes,
5. Stylo-maxillary ligament,
6. Intermaxillary ligament.

The *capsular ligament* extends from the glenoid fissure and zygomatic eminence to the neck of the lower jaw. It consists of strong fibres, though it is deficient internally and in front where the external pterygoid muscle is attached. This ligament is connected internally with the interarticular cartilage and synovial membranes, and externally with the external and internal lateral ligaments.

The *external lateral ligament* extends from the zygomatic process of the temporal bone at its root, to the neck of the condyle of the lower jaw, at its outer side. It is short and narrow, and is regarded simply as a thickening of the capsular ligament upon its external side. This ligament is hid by the parotid gland.

The *internal lateral ligament* extends from the spinous process of the sphenoid bone to the spine, which overhangs the posterior mental foramen; it is longer and thinner than the external, and serves to protect the inferior dental artery and nerve, which are situated between this ligament and the bone.

The *interarticular cartilage* is situated within the joint and divides it into two distinct cavities, which sometimes, however, communicate by an opening in the centre. This cartilage is oval transversely, and consists of concentric fibres, very compact, and more distinct and thick at the circumference than at the centre. It is attached to the capsular ligament, and by presenting a movable socket, is believed to strengthen as well as to guard against dislocations.

Of the *two synovial membranes*, the larger is superior and

covers the glenoid cavity, the cartilaginous portion of the zygomatic eminence, the upper surface of the interarticular cartilage, and the capsular ligament. The smaller synovial membrane covers the cartilaginous surface of the condyle, the lower surface of the interarticular cartilage, and is also reflected upon the inner wall of the capsular ligament. These synovial capsules are generally complete sacs, having no communication, and their *function* is to secrete a fluid to lubricate and thus facilitate the movements of this joint.

The *stylo-maxillary ligament* extends from the styloid process of the temporal bone to the angle of the lower jaw. It consists of a delicate aponeurosis, and has but little to do with the articulation.

The *intermaxillary ligament* also has little to do with the joint, and is hardly considered deserving the name of a ligament. It is seen extending from the external pterygoid plate and contiguous portion of the superior maxilla above, as an aponeurotic band, to the root of the coronoid process of the inferior maxilla below, and forming a common point of attachment for the buccinator and superior constrictor muscles of the pharynx. The motions of this joint consist of elevation, depression, the forward, backward, and lateral movement performed by the muscles of mastication.

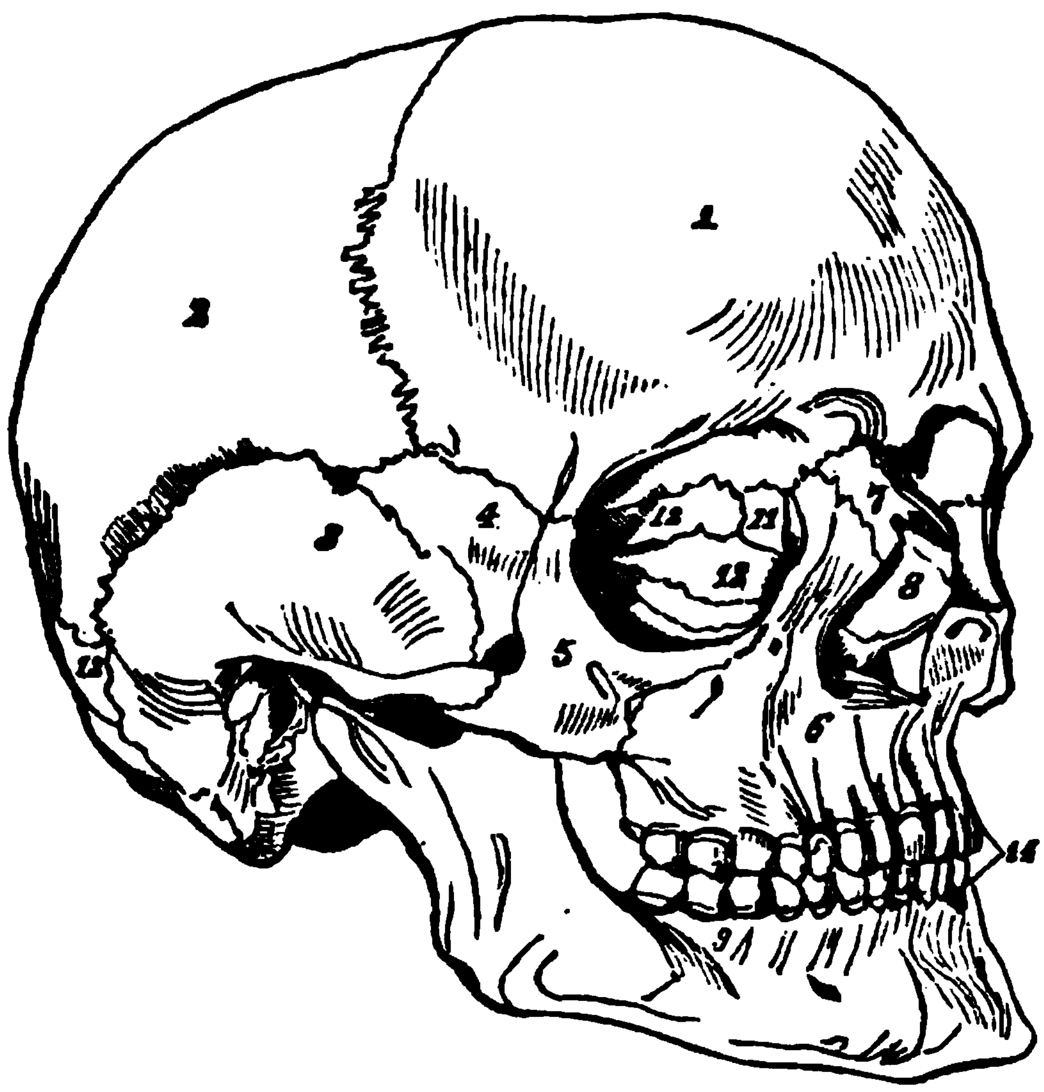
GENERAL REMARKS ON THE SKULL.

Anatomists distinguish in the skull five *regions*, an anterior, a superior, an inferior and two lateral regions, (Fig. 53.) The anterior region is the face, and presents somewhat the *form* of an oval. Its surface is very irregular, having cavities for the accommodation of two of the senses, seeing and smelling. Its outline may be traced by drawing a semi-circular line above, through the protuberances of the frontal bone, and extending it laterally round the external angular processes of the same bone, and thence continuing it along the outer margin of the malar to the lower jaw, running along its lower border. So that the facial

surface includes the bones of the face with a portion of the frontal bone.

In the *superior* part of this surface, on the median line, is seen the *nasal tuberosity*, on either side of which are the *superciliary ridges*. Below these are the *superior orbitary margins*, with the *supra orbital holes* at their inner third, for the transmission of the supra-orbital nerve and artery. Below the nasal tuberosity is the *nasal spine* of the *os frontis*, next are the nasal bones forming the bridge of the nose; on either side of which are seen the *nasal processes* of the *superior maxillary* bones, the *internal angular processes* of the *os frontis*, and still more externally the *openings of the orbits*. Below the *ossa nasi* are the *anterior nares*, on the inferior and central margin of which is the *anterior nasal spine*, and below this again are the *symphysis* of the upper jaw and the *alveolar arch* and *processes*.

FIG. 53.



On either side of the anterior nares are the *canine fossæ* for giving origin to the *levator anguli oris* muscle; above this is the *infra-orbital foramen*, transmitting the infra-

FIG. 53 represents the Bones of the Cranium and Face, with a few of the sutures. 1 Frontal bone. 2 Parietal. 3 Temporal. 4 Sphenoidal. 5 Malar. 6 Superior maxillary. 7 Nasal. 8 Vertical plate or septum of ethmoid. 9 Lower jaw. 11 Lachrymal bone. 12 Os planum of ethmoid. 13 Supernumerary bone. 14 Incisor teeth. Between 1 and 2, Coronal suture. Between 2 and 3, Squamous suture.

orbital vessels and nerve; and above this again is the *inferior* and inner orbitary margin, giving attachment to the levator-labii superioris alæque nasi, and covered by the orbicularis palpebrarum muscle.

The *malar bone* forms the outer boundary of the face; and the *lower jaw*, which projects forward into the chin, and backward and upward into the rami and processes, the inferior boundary.

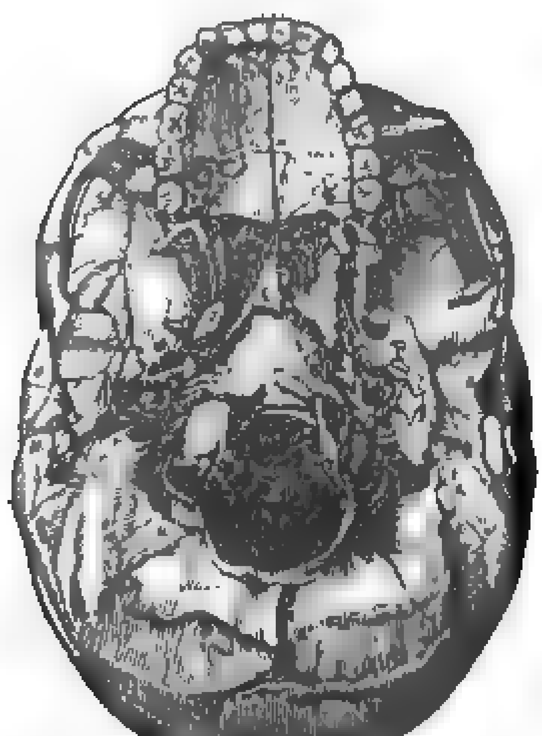
The cavities of the face are the orbits and the nose. The *orbits* are two hollow cones with their bases in front and their apex behind. The directions of their axes are backwards and inwards, and, if prolonged, they would intersect each other over the sella turcica, forming an angle of about 90 degrees. Seven bones enter into the composition of each orbit. The roof is formed by the *orbital processes* of the *frontal bone* and the lesser wing of the sphenoid. The floor is formed by the orbital processes of the *superior maxillary bone* and of the *palate bone*, together with a portion of the *malar*. The outer wall consists of the orbital surfaces of the greater wing of the *sphenoid* and *malar bones*, while the inner wall is composed of the *lachrymal*, the *os-planum* of the *ethmoid*, and part of the *sphenoid*.

Several foramina and openings communicate with the orbit. Behind are the *optic foramen*, giving entrance to the optic nerve and ophthalmic artery, and the *foramen lacerum superius* or *orbitale*, or the *sphenoidal fissure*, transmitting the third, fourth, first branch of the fifth, and the sixth nerves. At the lower and outer portion of the orbit is the *spheno-maxillary fissure*, in which is found the superior maxillary nerve and artery. There are also some small foramina penetrating the malar bone. On the inner wall are seen the *anterior* and *posterior ethmoidal foramina*—the former giving passage to the nasal branch of the ophthalmic nerve and the anterior ethmoidal artery, the latter to the posterior ethmoidal artery. At the *inner canthus* is the *nasal duct*, and in the *supra-orbital margin* the *supra-orbital foramen*. The ball of the eye with its muscles, vessels, nerves, and the lachrymal gland and its ducts, are all contained within the orbits.

The *nose* or *nasal fossæ* are two cavities situated upon either side of the median line, and separated by the *vomer* and *middle septum of the ethmoid.* They are bounded anteriorly and superiorly by the *nasal bones*, *cribriform plate* of the *ethmoid* and *sphenoid bones*, inferiorly by the *palatal processes* of the *superior maxillary* and *palate bones*, and externally by the *nasal processes* of the *superior maxillary*, *lachrymal*, *ethmoid*, *palate*, and inner plate of the *pterygoid process* of the *sphenoid.*

Each fossa contains *three turbinated bones*, a *superior*, *middle* and *inferior*, with three corresponding *meatuses.* The *superior meatus* communicates with the posterior ethmoidal and sphenoidal cells and the spheno-palatine foramen. The *middle meatus*, situated between the upper and lower spongy bones, looks into the *antrum*, and connects with the *anterior ethmoid cells* and *frontal sinuses.*

FIG. 54.



The *inferior region* or *base* of the skull is very irregular and reaches from the *nasal process* of the *os frontis* to the *external occipital protuberance.* It is divided into three regions, an *anterior*, *middle* and *posterior.* The *anterior* extends from the *superciliary arches* of the frontal bone to the *pterygoid processes* of the sphenoid, and includes the

FIG. 54 represents an external view of the Base of the Cranium. *aa* Hard palate. *b* Foramen incisivum. *c* Palate plate of the palate bone. *d* Point for attachment of azygos uvulæ muscle. *e* Vomer dividing posterior nares. *f* Internal or pterygoid process. *g* Pterygoid fossa. *h* External pterygoid Process. *i* Temporal fossa. *j* Cuneiform process of occipital bone. *k* Foramen magnum. *l* Foramen ovale. *m* Foramen spinale. *n* Glenoid fossa. *o* Meatus auditorius externus. *p.* Foramen lacerum anterius. *q* Foramen caroticum. *r* Foramen lacerum posterius. *s* Styloid process. *t* Stylo mastoid foramen. *u* Mastoid process. *v* Condyles of occipital bone. *w* Posterior condyloid foramen.

nasal spine and *orbital plates* of the os-frontis, with the *internal* and *external angular processes*, and the *ethmoid bone*.

The *middle division* reaches from the *pterygoid* to the *styloid processes*, and includes the *pterygoid*, *azygos*, and *spinous processes* of the *sphenoid bone*, the *glenoid cavities*, and *petrous points* of the *temporal*, with the *cuneiform process* of the *occipital bone*. In this region are found the *foramina ovalia*, *spinalia*, *corotica*, *glenoidea*, and *auditoria externa*. The *posterior division* reaches from the *styloid processes* to the *external occipital protuberance*, and includes the *styloid*, *vaginal processes*, the two *condyloid*, and the two *mastoid processes*, with their *digastric fossa*, the *jugular ridges*, the *inferior* and *superior transverse ridges*, the *protuberance*, and the *depressions* of the *occipital bone*.

The *foramina* in this division are the *foramen magnum*, the *anterior and posterior condyloid*, the *stylo-mastoid*, the *posterior mastoid*, the *foramen lacerum posterius*, and the *aqueductus cochleæ*.

The *two lateral regions* are divided each into three portions, an *anterior* or *temporal*, a *middle* or *squamous*, and *posterior* or *mastoid*. The *temporal division* includes the *temporal fossa*, and is bounded in front by the *malar* bone and the *external angular process* of the *frontal bone*; above by the *temporal ridge*, and below by the *zygomatic arch*. The anterior portion of the *squamous bone*, the *greater wing* of the *sphenoid*, the *malar*, and a part of the *frontal*, form this division, which is covered by the temporal muscle. The *temporal fossa* is continuous with the *zygomatic*, which latter is situated below the *zygoma*, between the *tuberosity* of the *superior maxillary*, and the *pterygoid process* of the *sphenoid*, and bounded externally by the *zygoma* and the *ramus* of the *lower jaw*. The *zygomatic fossa* contains the external pterygoid muscle, a portion of the temporal and internal pterygoid, with the inferior maxillary nerve, internal maxillary artery and branches.

The *squamous* division is formed by the *squamous portion* of the *temporal bone* and is covered by the temporal muscle. The *mastoid division* is posterior, and its most prominent

feature, the *mastoid process*, has been already noticed in the description of the base. The *superior region*, or *vertex*, is smooth and marked off by sutures (Fig. 53,) already detailed.

The *inner* or *cerebral surface* consists of the *arch* or *vault*, and the *base*.

The *vault* presents along the median line a *sulcus* for the *superior longitudinal sinus*. There are also seen *grooves* for the *middle meningeal artery*, and *depressions* for the *convolutions* of the *brain*.

The *base* has three divisions, an *anterior*, *middle*, and *posterior*. The *anterior division* includes the *crista galli* and *cribriform plate* of the *ethmoid bone*, the *orbital processes* of the *frontal*, and the *alæ minores* of the *sphenoid*. The *foramina* of this division are the *olfactory*, *foramen cœcum*, and the *optic*.

The *middle division*, called also the *middle fossa*, is situated between the *lesser wings* of the *sphenoid* and the *superior ridge* of the *petrous bone*, and bounded laterally by the *squamous portion* of the *temporal*. In the centre or on the median line, where the two fossæ approach, is seen the *sella turcica* bounded by its *four processes*, two *anterior*, and two *posterior clinoid*—on either side is a *groove* for the *cavernous sinus* and *carotid artery*, and external to this is the *middle fossa* for lodging the middle lobes of the cerebrum—on the *anterior surface* of the *petrous bone* are seen a depression for the *Gasserian ganglion*, the *hiatus Fallopii*, and the *eminences* marking the *vertical semi-circular canals*.

The foramina of this division are the *superior lacerated*, the *rotundum*, the *ovale*, the *spinale*, the *middle lacerated foramen*, and the *hiatus Fallopii*.

The *posterior division* extends from the *superior ridge* of the *petrous bone* and *posterior clinoid processes*, to the *transverse ridge* of the *occipital*. It includes the posterior surface of the *petrous bones*, on which are seen the *internal auditory foramina*, and the *aqueducts* of the *vestibule*. In the middle is the *cuneiform process*, on either side of and between it and the petrous bone are the *posterior lacerated foramina;*

posterior to the *cuneiform process* is the *foramen magnum*, and behind this is the *occipital surface* which presents two large *fossæ* for lodging the *lobes* of the *cerebellum*. These are separated by a *vertical ridge*, to which the *falx minor* is attached. Where the *vertical* and *transverse* ridges intersect, is seen the *internal occipital protuberance*, corresponding to the situation of the *torcular Herophili*, or the common point of junction of the great sinuses of the brain.

On either side of this protuberance is the *transverse ridge* to which the *tentorium* is attached, and below and parallel with this ridge is a *deep groove* which is continued along the inferior angles of the parietal and the mastoid portion of the temporal bone, and finally end in the *foramen lacerum posterius* of each side. This groove conducts the *lateral sinuses* out of the brain.

GENERAL DEVELOPMENT OF THE SKULL.

In the fœtus, the upper part of the face decidedly predominates, in consequence of the early development of the frontal bone. The middle portion or upper jaw is, on the other hand, very small from the absence of the maxillary sinus—so that the floor of the orbit and the alveolar arch almost meet. The alveolar border is prominent, owing to the presence of the germs of the teeth.

The lower portion of the face, consisting of the lower jaw, is also, at this period, contracted in its vertical diameter, and like the upper maxilla, from the presence of teeth germs, presents a similar prominence in its alveolar arch. The ethmoid bone is also, at this period, little developed in height. The transverse diameter of the face, on a line with the orbits, is great; at the lower part, small.

In the adult, the maxillary sinuses being developed, and the alveolar arches being widened and extended, give the face the characteristic expression of this period of life; while in the aged, the loss of the alveolar processes and teeth brings back again the face in a great measure to the fœtal condition. These remarks apply mostly to the anterior face. The posterior or *guttural* portion in the fœtus and

infant has the *rami* of the lower jaw very oblique instead of vertical, as in the adult. The posterior nares and the pterygoid processes look also obliquely forward and downward, while in the adult they become vertical by the development of the maxillary sinuses, carrying them backwards. The *palatine* region, from the same want of development in the maxillary sinus and forward obliquity of the pterygoid processes, is much shorter from before backwards, than in the adult.

It is thus seen how much the configuration of the face depends on the presence, absence, or partial development of these sinuses.

The cranium is remarkable for its early ossification, which commences first in the vault, though at birth it is found more advanced in the base. Indeed, at this period, the base is firm and immovable, while the vault has its bones separated by intervening membranes, which allow of considerable movement, so much so that during labor there is always more or less overlapping of the bones. It is at this period the anterior and posterior openings in the cranium, called *fontanelles*, are seen.

CHAPTER II.

ACTIVE ORGANS OF THE HEAD.

THESE organs include—

1. Organs of Digestion.
2. Organs of Expression and Speech.
3. Organs of Sense, including the Nerves.
4. Organs of Circulation.
5. The Fascia.

The *organs* of *digestion* comprise those of—

1. Prehension,
2. Mastication,
3. Insalivation,
4. Deglutition,

which constitute the *mouth.* The mouth contains the *dental organs*, and has its *superior wall* or *roof* formed by the *palatine processes* of the *superior maxillary* and *palate bones.* Its *floor* consists of the *mylo-hyoid muscles.* The *lips* bound it in front, the *soft palate* behind, and the *cheeks* laterally.

SECTION I.

ORGANS OF PREHENSION,

WHICH CONSIST OF THE MUSCLES OF THE MOUTH.

Dissection.—To expose the muscles of prehension, commence the first incision at the meatus externus of the ear, carrying it along the zygoma to the external canthus of the eye; thence round the lower margin of the orbit to the inner canthus, and up to the nasal spine of the os-frontis; from this continue the incision along the median line of the nose to its tip, thence down to the margin of the upper lip; from this continue round the margin and angle of the mouth to the middle of the lower lip; thence down to the lower margin of the chin; and thence along the sides and up the rami of the lower jaw, back to the place of beginning. Make a second incision from the prominence of the malar bone to the angle of the mouth. Turn the integuments from the ear towards the mouth. Hold the skin tense, and always dissect in the course of, and close to, the fibres of the muscle. The

FIG. 55.

FIG. 55 represents a front view of the Muscles of the Face. *a a* Anterior bellies of the occipito-frontalis. *b b* Orbicularis palpebrarum. *c* Pyramidales nasi. *d* Compressor nasi. *e e f f* Levator labii-superioris-alæque nasi. *g g* Zygomaticus minor. *h h* Zygomaticus major. *i i* Masseter. *j j* Buccinator or trumpeter's muscle. *k k* Orbicularis oris. *l l* Depressor-labii-inferioris. *m* Levator menti. *n n* Depressor-anguli oris. *o o* Levator-anguli-oris.

cavity of the mouth should first be filled with baked hair or tow, (soft paper will answer,) and then sewed up.

Levator labii superioris alæque nasi (Fig. 55) is a triangular and thin muscle, situated between the orbit and upper lip, and lying on the side of the nose. It *arises* by two heads, one from the nasal process of the *superior maxillary bone*, the other broad from the *orbitary margin* above the *infra-orbital foramen;* its fibres descend and are *inserted* into the *ala nasi* and *upper lip.*

Its function is to elevate the ala and upper lip. Its superior portion is covered by the *orbicularis palpebrarum,* and its orbital division is, by some, made a distinct muscle, and called the *levator labii superioris proprius.*

Depressor labii superioris alæque nasi is a small muscle situated on either side of the frenum, and is seen by raising the upper lip, and lifting the mucous membrane. It *arises* from the surface in front of the alveoli of the incisor and canine teeth, and ascends to be *inserted* into the upper lip and ala of the nose. It lies upon the bone, and is covered by the *levator labii superioris alæque nasi* and the *orbicularis oris.*

Its function is to depress the upper lip and ala nasi, and antagonize the levator.

Levator anguli oris (musculus caninus) is seen by raising the levator labii superioris alæque nasi which covers it. It *arises* from the *canine fossa* of the *superior maxillary* below the *infra-orbital foramen,* having the infra-orbitar nerves and vessels ramifying on its anterior surface. It descends and is *inserted* into the angle of the mouth, intermingling its fibres with those of the *orbicularis, depressor anguli oris,* and *zygomatic* muscles. Its function is to elevate the angle of the mouth.

Depressor anguli oris (or *triangularis oris*) is a triangular, flat muscle, having its base below and apex above. It *arises* fleshy and broad from the external oblique ridge of the lower jaw, ascends converging, and is *inserted* into the angle of the mouth, where its fibres blend with the levator anguli, orbicularis, and zygomatic. Its *function* is to de-

press the angle of the mouth, and antagonize the levator.

Levator labii inferioris (or *menti*) is seen by turning down the lower lip and lifting the mucous membrane. It *arises*, on either side of the frenum, from the surface in front of the alveoli of the incisor teeth of the lower jaw; its fibres descend and are inserted into the integument of the chin. Its function is to elevate the chin and lower lip.

Depressor labii inferioris (*quadratus menti*) is a broad muscle intermixed with fat, and situated upon either side of the symphysis. It *arises* from the side and front of the inferior maxilla at its base, and is *inserted* into the greater part of the lower lip and orbicularis muscle. Its *function* is to depress the lower lip.

Zygomaticus major is a long, slender muscle, and *arises* from the malar bone near the zygomatic suture. It is *inserted* into the angle of the mouth. Its function is to draw the mouth upwards and backwards, as in smiling.

Zygomaticus minor is very small. It *arises* from the malar prominence, and is *inserted* into the upper lip near the angle. This muscle is sometimes wanting, and sometimes it is simply a slip of the orbicularis palpebrarum by which its origin is covered. Its function is the same as that of the zygomaticus major. Both these muscles blend with the others which are inserted into the angle of the mouth.

Buccinator (βουκανον, a trumpet,) is situated at the side of the face, between the upper and lower jaws. It is a thin and broad sheet of muscle, the fibres of which run horizontally, and *arise* from the alveoli of the last molar teeth of the upper jaw, as far back as the pterygoid processes; from the external oblique ridge of the lower jaw, as far back as the coronoid process, and from the pterygo-maxillary ligament. It is *inserted* into the angle of the mouth and blends with all the other muscles inserted here. Its *function* is to retract the lips, to diminish the cavity of the mouth by drawing the cheek to the teeth, thus aiding in mastication; and to assist to puff out the cheek, as in filling wind instruments. It is covered by a quantity of fat, found in soft,

round masses, which separates it from the masseter muscle and ramus of the lower jaw, and by the zygomatic, the levator, and depressor anguli-oris muscles, together with the facial nerves and vessels which ramify over its surface. The duct of Steno is seen passing through this muscle at its upper part, opposite the second molar tooth of the upper jaw.

Orbicularis-oris consists of two semi-circular fleshy planes, surrounding the mouth, intersecting each other at the angles, and blending with all the muscles already described. It has one leading peculiarity in having no bony origin or insertion. Its *function* is to close the mouth and antagonize all the muscles inserted into its angles. This muscle constitutes the chief thickness of the lips, and is intermixed with small granulated particles of fat.

COMBINED ACTION OF MUSCLES.

The separate action of the several muscles concerned in *prehension*, is, as we have seen, to elevate, depress, retract, and close the lips; while in their conjoint and harmonious action, they either act separately or together, or in whatever way may best accomplish the great end for which they were designed. They are also engaged in other functions, as speaking, breathing and mastication.

BLOOD VESSELS SUPPLYING THE ORGANS OF PREHENSION.

1. Facial Artery. 2. Infra Orbitar. 3. Transverse Facial.

The *Facial Artery* (Fig. 73) arises from the external carotid, at its front part, above the lingual, and ascends to the submaxillary gland behind, by which it is covered. It now curves over the base of the lower jaw, anterior to the masseter muscle, ascends to the commissure of the lips, thence by the side of the nose to the angle of the eye, where it terminates by anastomosing with the ophthalmic. Its whole course is very tortuous, to adapt it to the various movements of the jaws.

Its branches are, the inferior palatine, submaxillary,

submental, pterygoid and masseteric, inferior labial, inferior coronary, superior coronary, lateralis nasi, and angular. Of these branches, the latter are mostly concerned in nourishing the organs of prehension. The *inferior labial* supplies the skin and muscles of the lower lip. The *inferior coronary*, leaving the facial at some distance from the angle of the mouth, proceeds along the border of the lower lip, and unites with its fellow of the opposite side. The *superior coronary* pursues a similar course along the border of the upper lip, uniting with its fellow and sending a branch to the septum nasi. The *lateralis nasi*, and the *angular* termination of the facial, supply the ala and dorsum of the nose and the angle of the eye.

The *Infra-orbital* is a branch of the internal maxillary, which, passing along the infra-orbital canal, comes out at the infra-orbital foramen, supplying the muscles of the upper lip, and anastomosing with the *facial, transverse facial, alveolar, buccal* and *ophthalmic* arteries.

The *Transverse Facial* (*transversalis faciei*) comes from the external carotid in the substance of the parotid gland; sometimes it is a branch of the temporal; it runs parallel to the duct of Steno, crossing the masseter muscle, supplying the lateral parts of the mouth, and anastomosing with the facial and infra-orbital arteries.

The *Veins* correspond to the arteries and terminate in the internal jugular.

The *Nerves of Prehension* (Figs. 74, 97) belong to the 5th and 7th pair, which will be described under the heads of organs of mastication and expression.

SECTION II.

ORGANS OF MASTICATION.

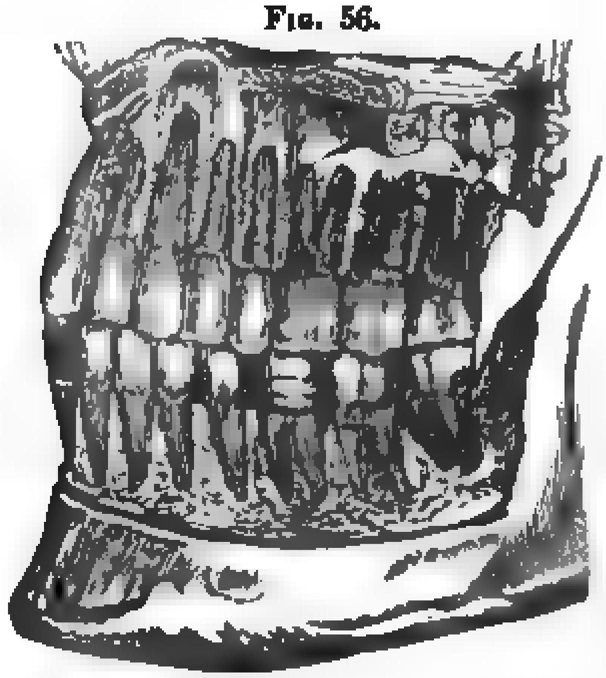
These organs are divided into the *passive* and *active*. The *passive organs of mastication* are

THE TEETH.

The teeth constitute the immediate agents in mastication, are the hardest portions of the body, and form an

essential element in the classification of the animal kingdom. They occupy the alveolar cavities of the superior and inferior maxillary bones, and are fixed firmly in their respective situations by a species of articulation called *gomphosis* (γομφος, a nail,) from the supposed resemblance to the manner in which a nail is confined when driven into a board, as seen in Fig. 56.

Fig. 56.



The teeth in both jaws are arranged in what have been called the dental arches. The size of the arches in the two jaws differs; that of the upper closes over the incisors and canine of the lower, and thus forms the segment of a larger circle—this overlapping in the two arches illustrates their adaptation to the cutting action; and they have been compared to the blades of a pair of scissors. The molars, which come in contact by the superior surface of their crowns, have that position which is best adapted for the grinding and pounding motions. Fig. 75, from Nasmyth, illustrates the superior dental arch of man; and the same figure shows the superior arch of a chimpanzee. This latter presents a marked difference from the human arch, in having its lateral portions straight, and in presenting a space between the lateral incisor and canine.

The teeth have two grand divisions:

First, the Temporary; Second, the Permanent.

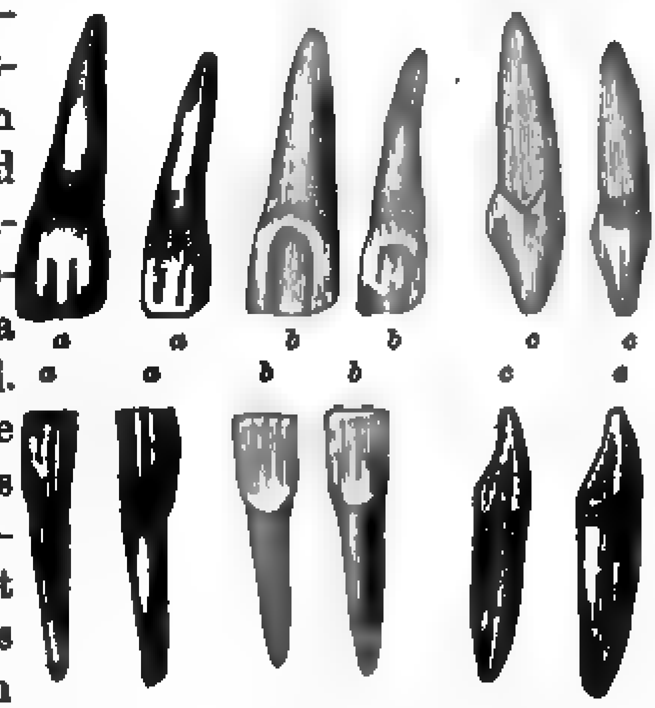
The first division has 20 teeth; the second 32. Each division is classified into,

1. Incisors—(incisores.)
2. Canines—(cuspidati.)
3. Bicuspids—(bi-cuspidati.)
4. Molars—(molares.)

Description of a Tooth.—Each tooth consists of a crown, neck, and root or fang. The crown is external, naked, has no investment of periosteum like the bones, but is covered by a substance called enamel. The neck is the contracted portion of the tooth, surrounded by the gum; while the root, firmly fixed in the alveolar walls, is covered by the periosteum reflected from the alveoli, and has its apex perforated for the entrance of a nerve and artery.

Description of each class of Teeth, beginning with the permanent division. The *Incisors* (*incido,* to cut,) are situated in the anterior and central alveoli of the upper and lower jaw. They are four in number in each jaw—two central and two lateral. The crown of each is wedge-shaped and sharp, smooth and convex in front, concave behind, and covered with a thick coating of enamel. The cutting edge is the widest part, and continues narrowing to the extremity of the fang. The root has a conical form—is single, and flattened on its side, and has an opening at its apex for the passage of the vessel and nerve to the pulp. Those of the upper jaw are larger and stronger than those of the lower. The central incisors of the upper jaw are larger than the lateral; while in the lower, the lateral are larger than the central, though the difference is slight.

Fig. 57.



The superior central incisors are the *broadest* of all the front teeth, measuring about four lines in their crowns. The inferior central incisors are, on the contrary, the smallest, measuring only about two lines and a half.

Fig. 57, a a a a Anterior view of the Incisors; b b b b Posterior view; c c c c Lateral view.

The superior central incisors are the *longest* of all the front teeth except the canine, being found to have an average measurement in length of about twelve lines; while the inferior central incisors are but ten lines long, and are the shortest of all the teeth. The relative length of the crown and root, though subject to variation, is nearly equal in the upper central incisors, while in the inferior central incisors four lines are assigned to the crown and six to the root. For the lateral incisors of both jaws, four lines and a half for the crown and seven for the root are regarded as the fair relative average length. The anterior surface of the central incisors is frequently marked by longitudinal ridges, which in early life are found to terminate in small cusps upon the cutting edge of these teeth—three of these cusps are seen on the central, and but one on the lateral incisor. This serrated provision in the incisors is believed to be nicely adapted to the division of the food, and designed to compensate for the weak condition of the dental system and its muscular powers at this early period. As the permanent teeth advance these cusps disappear.

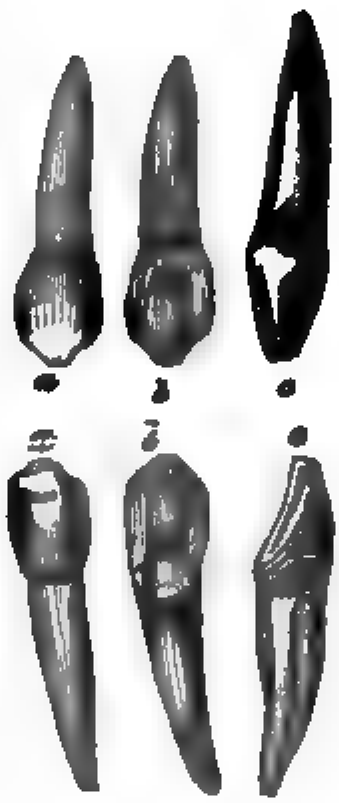
On the posterior surface of the superior central incisors, which have been stated to be concave, and receive the crowns of the lower incisors at an acute angle, raised undulations are described to exist in early life, and are regarded as assisting in the mastication of the food at this time, when the molars are imperfect.

Professor Harris describes four surfaces to the crown of an incisor, which he thus characterizes: two approximal, one labial, and one palatine or lingual surface; also four angles, a right and left labio-approximal, and right and left palato-approximal, or lingua-approximal.

Canine, or *Cuspidati*—(*cuspis*, a point.) The canine teeth are two in each jaw, and situated one upon either side of the lateral, and with the incisors complete the range of what are called the *oral teeth*. They particularly distinguish the carniverous animals, and are designed to tear and rend the food, whilst the incisors simply cut. The crown is conical, and has its anterior surface more con-

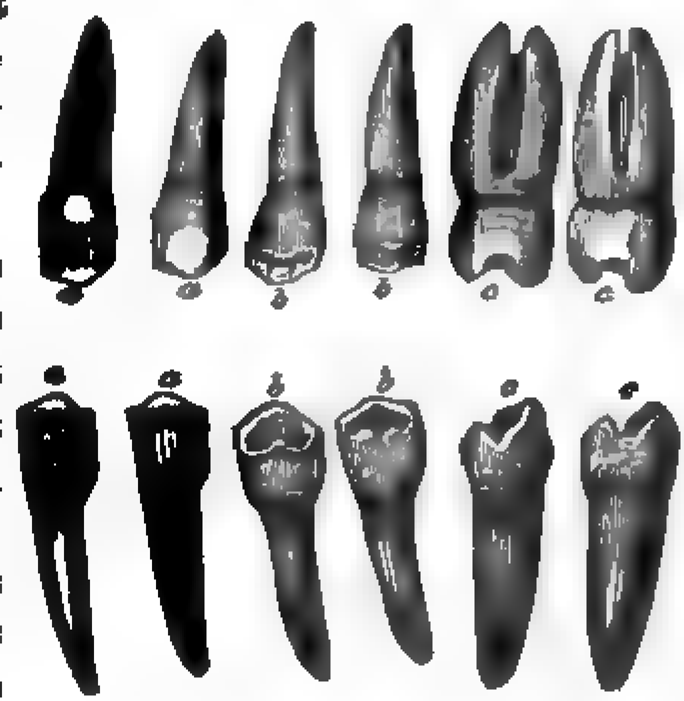
vex than the incisors, and the posterior more irregular, and possessing a larger tubercle near the neck. The roots are the longest of all the teeth—larger than the incisors; single, but marked by a groove, showing an attempt towards the double root.

Fig. 58.



The roots of the upper canines are seen to extend into the nasal process of the superior maxilla, above the floor of the nostrils—and those of the lower are found to descend about one half of the depth of the lower jaw, and to be midway between the anterior mental foramen and the *symphysis menti*. The superior edge of the upper canine is greater than that of the lower, the former being estimated at about four lines, the latter about three and a half. The upper canine is larger than the lower, measuring about thirteen lines—to the crown is given six lines for its length, and to the root seven lines. The root is not unfrequently found curved or undulating.

Fig. 59.



The canine presents on the middle of its anterior surface a ridge which ends on the summit in a cusp. On either side of this middle ridge, two other ridges are seen but not ter-

Fig. 58, *a a* View of the Cuspids, or canine, from before; *b b* View of the same from behind; *c c* Side view.

Fig. 59, *a a a a* View of the Bi-cuspids from without; *b b b b* View from within; *c c c c* Side view.

minating in cusps. On the posterior surface "undulating ridges," running transversely, are seen, but more distinct in the upper than in the lower canines. The summits of the canines are tubercular and oblique, and their cusps disappear in the adult.

Bi-Cuspids (*Bi-Cuspidati*—Fig. 59.)—The bi-cuspids are upon either side of the canines, and are four in each jaw; they are intermediate in size between the canines and molars, and derive their name from having two tubercles on their grinding surfaces. A groove running in the direction of the alveolar arch separates these tubercles; the outer is larger than the inner, and those of the upper larger than those of the lower jaw. The body is thicker, and the sides are flatter, than either the incisors or cuspidati. Their roots are single, though the groove is much deeper than the canine, and often divides it into two.

The necks of the bi-cuspids are smaller, in proportion to their crowns, than those of any other teeth; hence the necessity of using more caution in their extraction, as they are more liable to fracture.

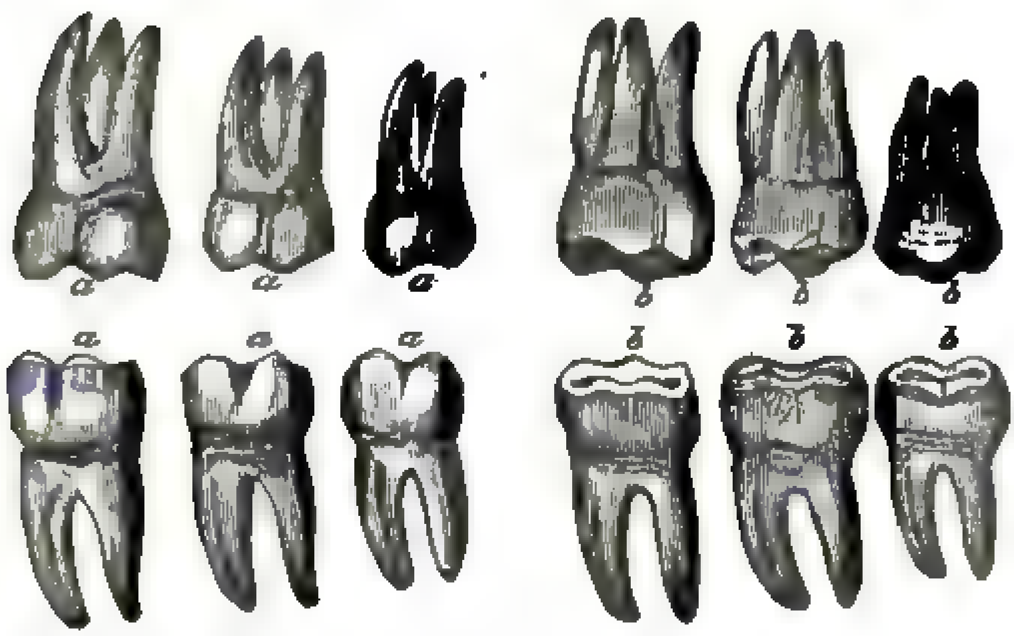
Professor Harris gives a bi-cuspis five surfaces, two *approximal*, one *buccal*, one *palatine* or *lingual*, and a *grinding surface;* also four angles, one anterior, and one posterior *palato-approximal*, and one anterior, and one posterior *bucco-approximal*.

Molares, or *Multi-Cuspidati*.—The posterior teeth in the alveolar arch of each jaw constitute the true molars or grinders, and with the bicuspids form what is called the buccal range. There are six to each jaw, three upon either side behind the bicuspids. Their greater size distinguishes them. The crown of each presents a square form, and has on the grinding surface four and five tubercles, with as many depressions, which are so arranged that the tubercles of either jaw are adapted to corresponding depressions in the other.

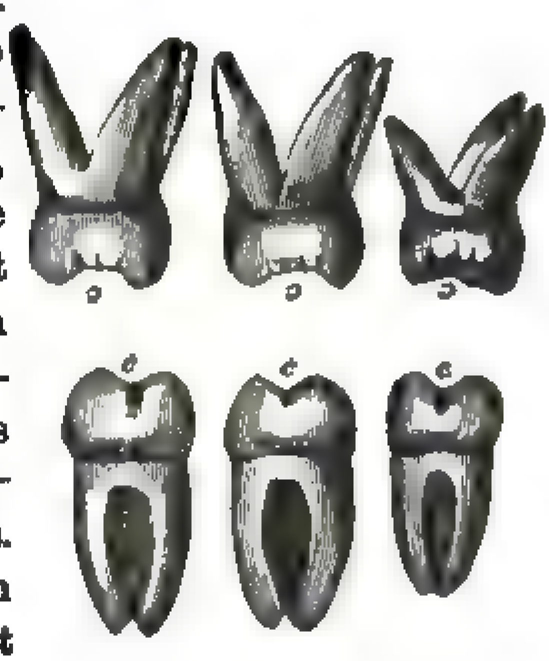
There are three roots, and sometimes four, to the upper molars; two of these roots are external, nearly parallel and vertical. The third is internal, directed to the roof of the

mouth, and forms an acute angle with the other. The molars of the lower jaw have but two roots, the one anterior, the other posterior; they are flattened very much laterally, grooved, and sometimes bifid. The first molar is the largest, the third or last, called *dens sapientiæ*, is the smallest and shortest. The wisdom tooth of the upper jaw has its roots sometimes united into one, while the root of the lower is

Fig. 60.



conical and generally single. The roots of the first two upper molars are situated beneath the floor of the antrum, and occasionally perforate this cavity. Those of the last inferior molars are found in the base of the coronoid processes. The apex of all the roots are perforated for the transmission of vessels and nerves.



The roots of the molar teeth in both jaws are found not unfrequently to approach each other, and thus enclose the osseous wall which divides them. From this arrangement they offer considerable difficulty to extraction. The inter-

Fig. 60, *a a a a a a* Exterior view of the molars. *b b b b b b* Interior view. *c c c c c c* Lateral view.

nal root of the upper molar is seen sometimes to be joined by a "broad plate" to the anterior external, and then again all three have been found united in one mass. The roots of the lower molars are seen occasionally to be similarly connected. And, indeed, so great is this irregularity in the roots of the molars, as to length, figure and direction, that, according to Mr. Nasmyth, it is impossible to tell beforehand the amount of resistance to be encountered in their removal. The average length of a molar he estimates at from eight to thirteen lines.

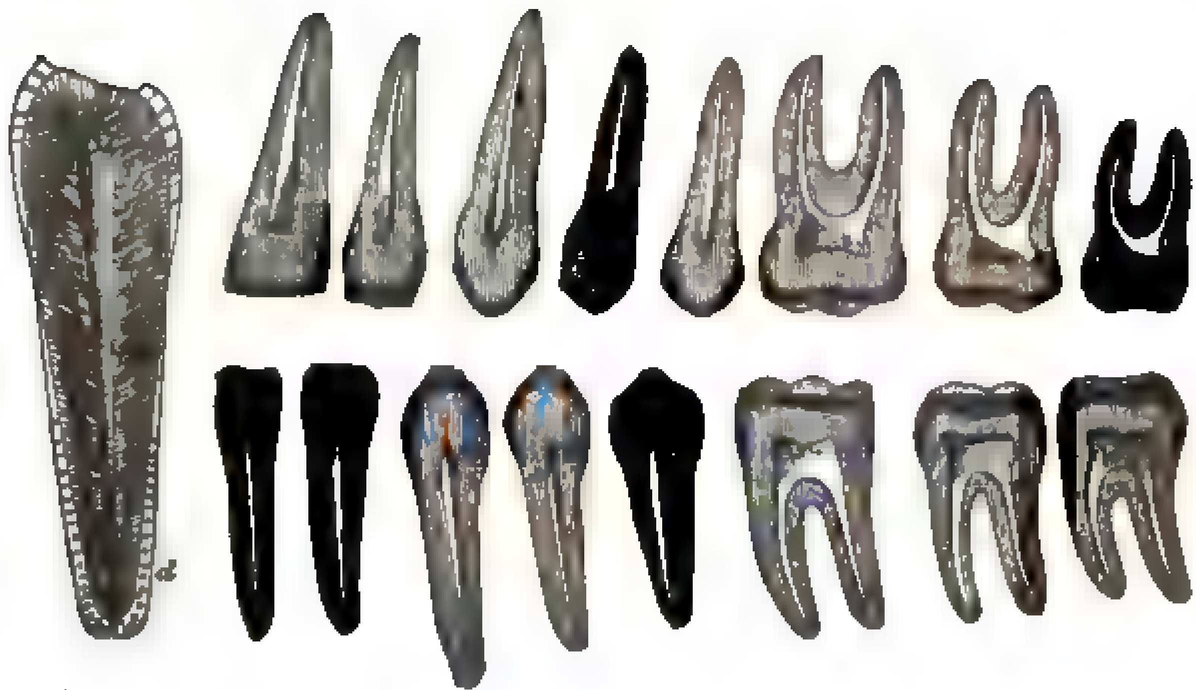
In reference to the function of the molars, this same gentleman uses the following language: "The mechanical disposition of the molar teeth is beautifully fitted to the purposes which these organs have to fulfil; for example, the first act of mastication, consisting in the closure of the lower against the upper jaw, while it secures the food, makes its greatest force of pressure against the outer limb of the crown of the superior molars, that limb which we know to be supported by two out of the three roots of the tooth.

"Again, when trituration ensues, the ramus of the jaw is drawn inwards, and the chief amount of pressure is transferred to the outer limb of the lower molars, where the greatest strength of fang exists."

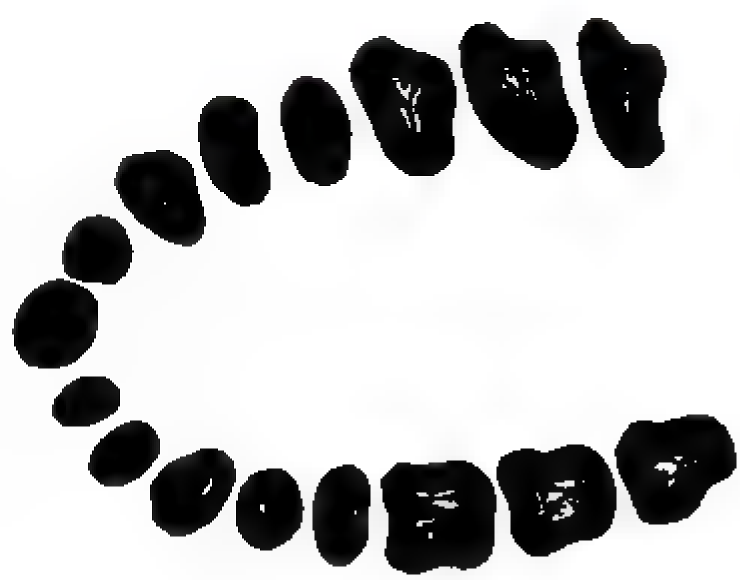
Structure.—The structure of each tooth consists essentially of three parts, the *pulp*, *dentine* or *ivory*, and *enamel*, to which the *cementum* or *crusta-petrosa* is added, (Fig. 61, A.) Each tooth contains within itself a cavity for lodging the pulp, called the *pulp cavity*, (Fig. 61, B, C.) The shape of the cavity corresponds to that of the tooth to which it belongs. The dental pulp has the same form as the cavity, and is described by Mr. Thos. Bell, as "very soft, gelatinous, and semi-transparent, and having its surface covered by an extremely delicate, thin, vascular membrane, closely attached to it by vessels."

The vessels (Fig. 62, from a drawing by Mr. Nasmyth) which supply the pulp, enter the tooth at the apex of its root, forming a capillary net-work on the pulp, and show

A Fig. 61. B



C



the great vascularity of this tissue; the larger vessels are deep, and run tortuously in the longitudinal direction; the arteries and veins communicate by an immense number of looped capillaries, as seen in the drawing.

The nerves of the *pulp* (Fig. 63, taken also from Mr. Nasmyth) come from the superior and inferior maxillary divisions of the fifth, accompany the artery, and are seen to form a series of loops. The pulp thus seems to be constituted of blood vessels and nerves, surrounded by a very delicate membrane.

Fig. 61, A represents the different structures composing a tooth. *a* Pulp. *b* Dentine. *c* Enamel. *d* Crusta-petrosa, or cementum.

Fig. 61, B represents the *pulp cavities* of the permanent teeth from vertical sections.

Fig. 61, C represents the *pulp cavities* of the permanent teeth of both jaws, from transverse sections at their necks.

MICROSCOPIC ANATOMY OF THE PULP.

Fig. 62.

Fig 63.

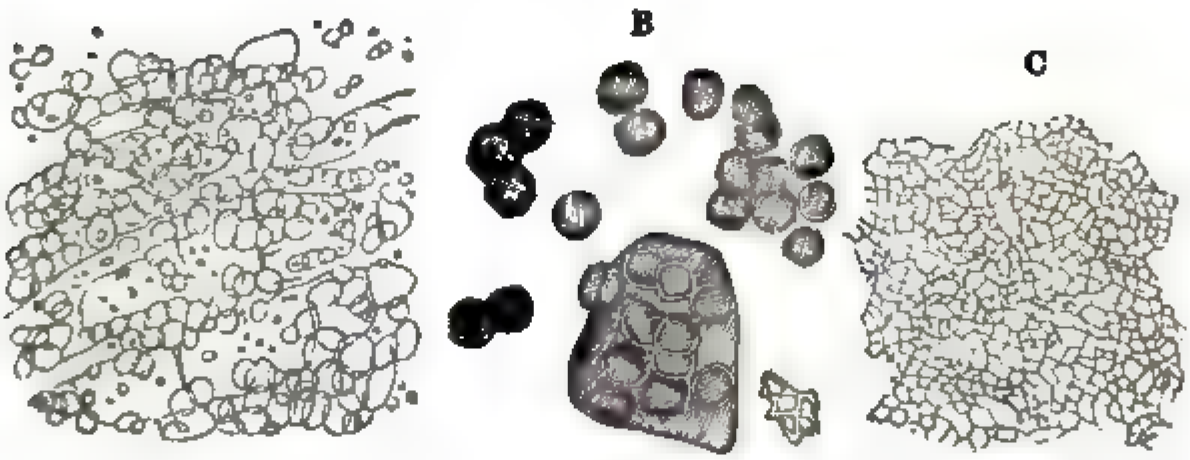
According to the microscopic observations of Mr. Nasmyth, the pulp consists of a structure essentially *cellular*, (as exhibited in Fig. 64, A.) which he calls the reticular tissue. These cells constitute the "principal

Fig. 62 represents the vascularity of the pulps of one of the central incisor teeth of the upper jaw. The deeper vessels are seen to be large, and the looped communication between the capillary arteries and veins is distinctly shown. The small figure shows the pulp of natural size.

Fig. 63 represents the pulp of an adult bi-cuspid, and the arrangment of its nerves—magnified twenty times.

portion" of the bulk of the tooth. They vary very much in size and shape, being estimated from the ten-thousandth to the one-eighth part of an inch in diameter. They are disposed throughout the pulp in concentric layers, and have granules interspersed among them.

A . FIG. 64. B C



The microscope of this gentleman also shows the pulp cells to consist of a membrane, cavity and nucleus. The nucleus generally occupies the lateral portion of the cell-wall, though sometimes found in the centre of its cavity. The nuclei of all the cells are composed of animal tissue, and remain as such without any transformation; while the cells themselves undergo a "conversion" into ivory, by the deposition in their interior of calcareous salts. The nuclei, arranged in a "linear succession," constitute "the fibres of the ivory,"

A. FIG. 65. B.

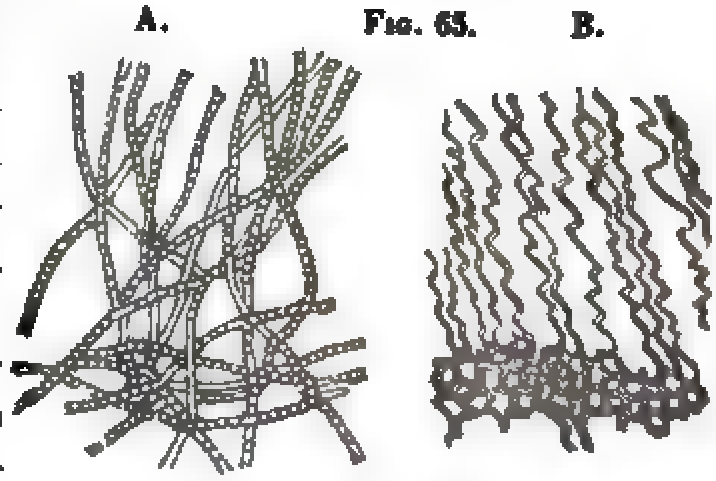


FIG. 64, A, the Cellular arrangement in a portion of the body of the pulp.

FIG. 64, B represents the presence of Vesicles on the superficial layer of the pulp—not an unfrequent occurrence according to Mr. Nasmyth.

FIG. 64, C, another variety in the arrangement of the Cells of the pulp.

FIG. 65, A represents the baccated or beaded appearance of Dentine, according to Mr. Nasmyth.

FIG. 65, B represents a portion of the Pulp, as well as the ivory, and shows the fibres to be continuous with the parietes of the cells.

and are imbedded in the osseous substance. These fibres are solid, instead of tubular as supposed by Retzius and others,—and they present (from the peculiar arrangement of their nuclei) a beaded or "*baccated*" appearance—as seen in Fig. 65, A.

The fibres of the pulp are observed to be *spiral* in their course, but less so, and rather undulating where the ivory is deposited around them. The pulp is enclosed in a double sac—the outer one stated by Mr. Hunter to be "soft, spongy, and without vessels," while the inner is very vascular and firm. Mr. Blake on the other hand makes the outer to be full of vessels, as well as spongy, and the inner to be destitute and delicate. The injections of Mr. Fox, preparations of Mr. Bell, and observations of Professor Harris, all seem to show that both membranes are decidedly vascular. At an early period when this sac, termed the dental capsule, is about to close its follicular stage, from being a mucous membrane, presents, according to Mr. Nasmyth, a "white, silvery, loose, and rugous" appearance, which, under the microscope, exhibits minute cells differing from those of the epithelium, while the internal layer of the sac, according to this same authority, presents layers of loose cells, of oval shape, containing nuclei and some granular matter, but destitute of vessels. This layer, however, he states, has beneath it a net-work of vessels, "supported by a web of areolo-fibrous tissue," which readily accounts for both layers of the capsule being considered vascular.

The dental capsule is found to be connected with the alveolar periosteum, and so blended with it, as to be considered a single membrane. Mr. Bell makes one of its attachments inseparable from the gums, and the other connected with the pulp, where the vessels and nerves enter.

DENTINE OR IVORY.

Dentine or *Ivory*, (see Fig. 61, A,) forms by far the most abundant constituent of a tooth, composing the whole of the body, root and neck, excepting the thin cov-

ering of enamel, the crusta petrosa, and pulp. Its color is a yellowish white, and presents when broken a fibrous appearance. It is harder than bone. Chemical analysis makes ivory to consist, in 100 parts, of

Phosphate of lime,	61.95
Fluate of lime,	2.10
Carbonate of lime,	5.30
Phosphate of magnesia,	1.25
Soda and chloride of sodium,	1.40
Cartilage and water,	28.00

According to Mr. Nasmyth, ivory presents three varieties. The first, consisting of a "regular series of fibres and cells," called *fibro-cellular*, and regarded as the most perfect kind of ivory, forms the greater portion of the teeth of man, and is found to strongly characterize both classes of the *mammalia* and *reptilia*. The second variety of ivory presents vertical canals traversing it, as seen particularly in the teeth of fish, and is called *canalicular*. The third variety, from exhibiting, like bone, little corpuscular bodies scattered through its substance, receives the name of *corpuscular ivory*. Specimens of this latter are noticed in the teeth of the walrus, sloth, &c., and is stated to exist in the human tooth, sometimes, when diseased.

The structure of the dentine, and its relation to the pulp, are seen in Fig. 61, A, after Retzius; here the fibres are represented as tubular, the tubes or dental canals opening by circular orifices in the pulp cavity, from which they traverse the body of the tooth, in a curvilinear direction, to end in cul de sacs at the outer margin of the dentine, or at the enamel. These tubes are represented as having distinct parietes, branching in their course, some bifurcating at their termination, others at their middle, and containing a serous fluid, which is supposed to be intended for the nourishment of the tooth, by imbibition. It appears from Mr. Nasmyth's later experiments that the structure of dentine is, like that of the pulp, essentially *cellular* and *fibrous*—that is, consisting of cells and fibres—and that these cells assume

FIG. 66.

different shapes in different animals, so much so, indeed, as to be regarded an important feature in the classification of the animal kingdom. But notwithstanding the difference in shape, in the ivory cells of different animals, they all nevertheless have one character in common, i. e. their *baccated* (or beaded) appearance as seen in Fig. 65, A. The beads represent the nuclei of the different cells, which, as before stated, consist of animal tissue, remain as such, and, connected in a linear series, constitute the fibres of the ivory,—while around the fibres, and within the cells, is deposited the calcareous matter, giving hardness, density, and strength to the ivory. The fibres themselves are also found to be solid, instead of tubular as Retzius thought, and the interfibrous substance, instead of being structureless, to consist of organized cells.

BLOOD-VESSELS OF DENTINE OR IVORY.

The vascularity of dentine is generally denied by anatomists; but Fig. 66, taken from an injected specimen in the possession of Professor Harris, seems clearly to show it has a circulation, and in his Principles and Practice of Dental Surgery, he states that similar specimens are in the possession of Dr. Maynard. In vol. 2 of the American Journal of Dental Science, the doctor uses the following language in explanation of the above figure, "the second time he had the good fortune to make this discovery, it was in the half of an inferior molaris, taken from the

mouth of a boy eleven years of age, and of which an exact representation of a microscopic view of it is annexed. (Fig. 66.) The tooth had ached violently for several days previous to its extraction, from which circumstance he was induced to believe that the vessels of the pulp were highly injected, and to satisfy himself upon the subject, he soon after its removal split it open with a strong pair of excising forceps. As was anticipated, the vessels of the pulp were filled with red blood, and on examining the half of the tooth in which this had remained, through a microscope, a *number of vessels within the very substance of the bone*, charged with this fluid, were distinctly seen." The crown is represented as decayed.

Formation of the Dentine.—The ossification of a tooth, it is well known, commences on the surface of the pulp, and according to the experiments of Mr. Hunter, from feeding animals on madder, this ossific matter is laid layer within layer, from the surface to the centre, till the tooth is completed, the pulp retiring and diminishing as ossification advances.

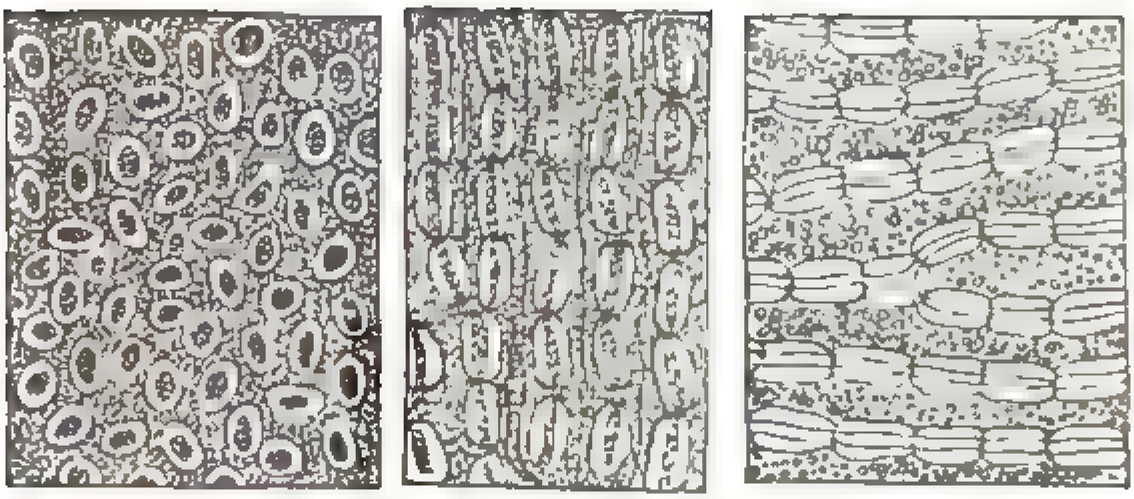
The incisors begin to ossify by three points, the cuspids by one, the bicuspids by two, and the molars by three, four, or five, according to the number of projections or tubercles upon their grinding surface. The crown of the tooth being formed, the roots are next observed to be developed, and their number always previously indicated by the number of distinct vessels and nerves going to the pulp.

This view of the formation of dentine has been termed the *excretion theory.* The later researches of Mr. Nasmyth give another view of the subject; observing the similarity of structure between the pulp and dentine, that each possessed the cellular or reticular arrangement, (in his own comprehensive language) he remarks, "My theory, indeed, is most simple, the cells of the pulp are converted into ivory cells by the deposition within them of earthy salts, and the cells so converted, with their nuclei, are the perfect ivory; moreover, the nuclei assume a peculiar arrange-

ment and constitute the structure which I have described and demonstrated by the name of baccated fibre." See Fig. 65, A.

Fig. 67.

A B C



Mr. Tomes makes three stages in the formation of dentine or ivory. 1st. The *Areolar*, consisting of a very fine tissue, which he calls the preparatory stage. 2d. *Cellular*, (Fig. 67, A,) in which the cells are scattered irregularly and have no definite arrangement. 3d. The *Linear*, where the cells (Fig. 67, B) are disposed in regular rows, vertical to the coronal surface. From this third stage, Mr. Tomes thinks, the regular, continuous, permanent tubes of dentine result—these vertical cells becoming united, end to end, opening into each other and forming a communication: so that if the baccated appearance of Mr. Nasmyth is seen, it is regarded as an arrest of development, and exhibiting dentine in an imperfect state.

The Enamel (Fig. 61, A) covers the crown of the tooth; is thickest upon the cutting and grinding surfaces, and is much the hardest portion. Its hardness is so great as to strike fire with steel, and resist the file or saw; hence it is well suited to oppose the pressure and friction to which it is constantly liable. Its color is a pearly white, and it is very brittle. It is found to consist of fibres, or minute

Fig. 67, A represents the Dentine in its second stage.

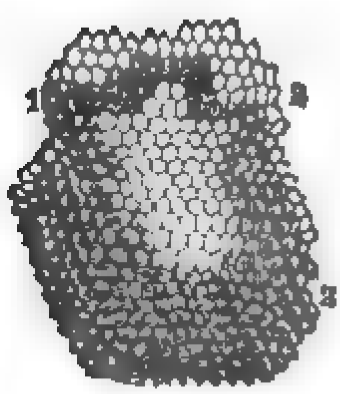
Fig. 67, B represents the Dentine in the early part of the third stage.

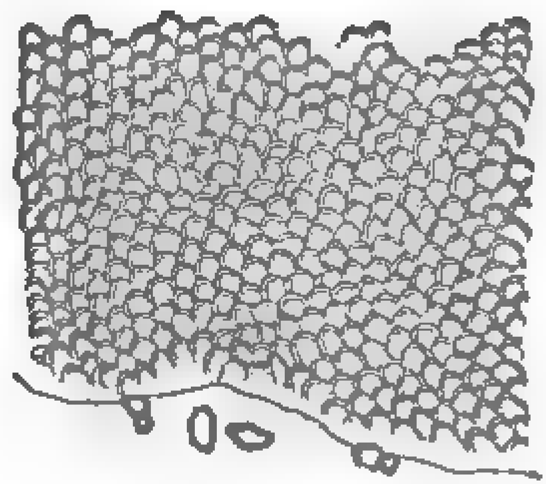
Fig. 67, C represents the Dentine at the completion of the third and most perfect stage.

hexagonal prisms, arranged perpendicularly to the surface of the *ivory* parallel to each other, and having one of their extremities resting upon the ivory, and the other forming the free surface of the crown, as seen in Fig. 68, A. A thin membrane is described as separating the enamel from the ivory, and is found, by Mr. Nasmyth, to be composed of cells. The enamel, like ivory, consists also of animal and earthy matter, and is chemically composed, according to Berzelius, in 100 parts, of

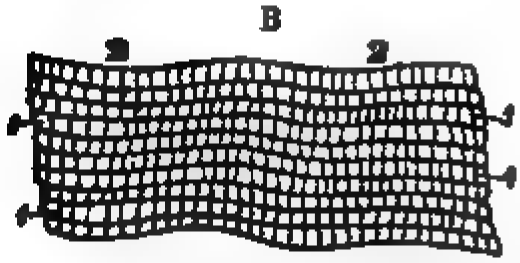
Phosphate of lime,	85.3	Phosphate of magnesia,	1.5
Fluoride of calcium,	3.2	Soda and muriate of soda,	1.
Carbonate of lime,	8.	Animal matter and water,	1.

A FIG. 68. C





B



Crusta-petrosa (or *cementum*) (Fig. 61, A) forms a thin coating of osseous lamina to the root of the tooth, from the neck where the enamel ends, to the apex of the fang. In some animals—as the elephant—it is continued over the enamel as a thick layer. In structure, it has the calcegerous cells and tubuli, and consists of true bone. Its quantity increases as age advances, and presents, sometimes in old people, an exostosis on the

FIG. 68, A represents the hexagonal termination of the Enamel fibres. 1, 2, 3, show the irregular crevices between the hexagonal fibres.

FIG. 68, B represents a lateral view of the Enamel fibres. 1 1 Enamel fibres; 2 2 Transverse stripes.

FIG. 68, C represents a view of the Enamel on a vertical section.

though the term is most usually restricted to misplacement in position and number.

The permanent teeth most frequently deviate from their natural places and exhibit *irregularity* in their arrangement. The incisors and cuspidati, it is said, present an improper direction oftener than any of the other teeth. Some teeth may be said to vary in improper direction when they are out of the line of the proper arch, and project either too far forwards or too far backwards; or when, with this deviation, there is an additional irregularity, by which they are turned about and have their anterior and posterior surfaces presenting very obliquely forwards and backwards. Another irregularity in position is, where the teeth change places; thus the central incisor has been seen to take the place of the lateral, and the lateral of the central. Again, irregularity of teeth may occur not only in consequence of change of position, but different parts of the tooth itself may change, as in the upper jaw, for example, the crown may be above and the roots below, looking towards the alveolar surface—an instance of which is seen in the Museum of the Baltimore College of Dental Surgery.

The *irregularity* in number may be either a deficiency or excess. Instances are cited in which the teeth have all been wanting, or a great number have been absent; or, as we are told, they have been fused together so as to constitute but a single piece. Those which exceed in number are called *supernumerary teeth.*

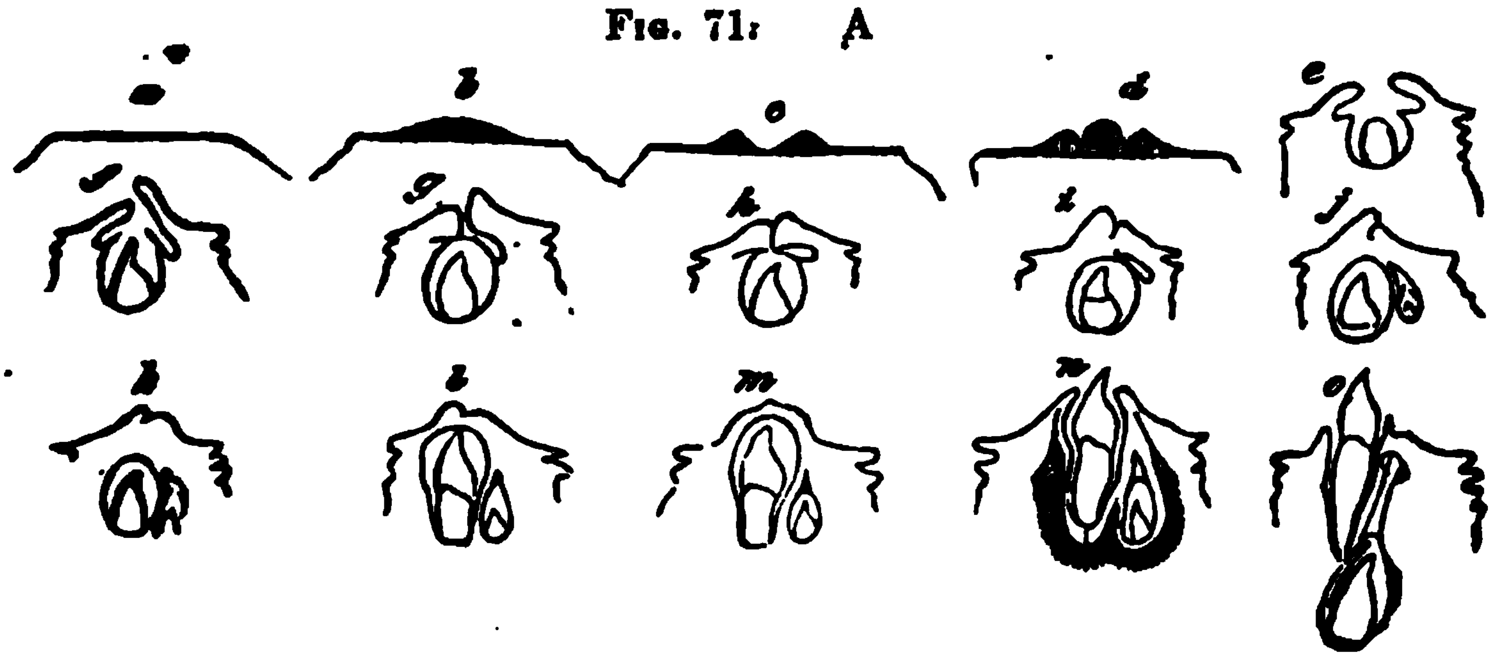
Irregularity in time of appearance is equally great. Teeth have been seen at birth, and on the other hand, not till ten years of age. These may be regarded as the extremes, between which we find every intermediate shade of variety.

SECTION III.

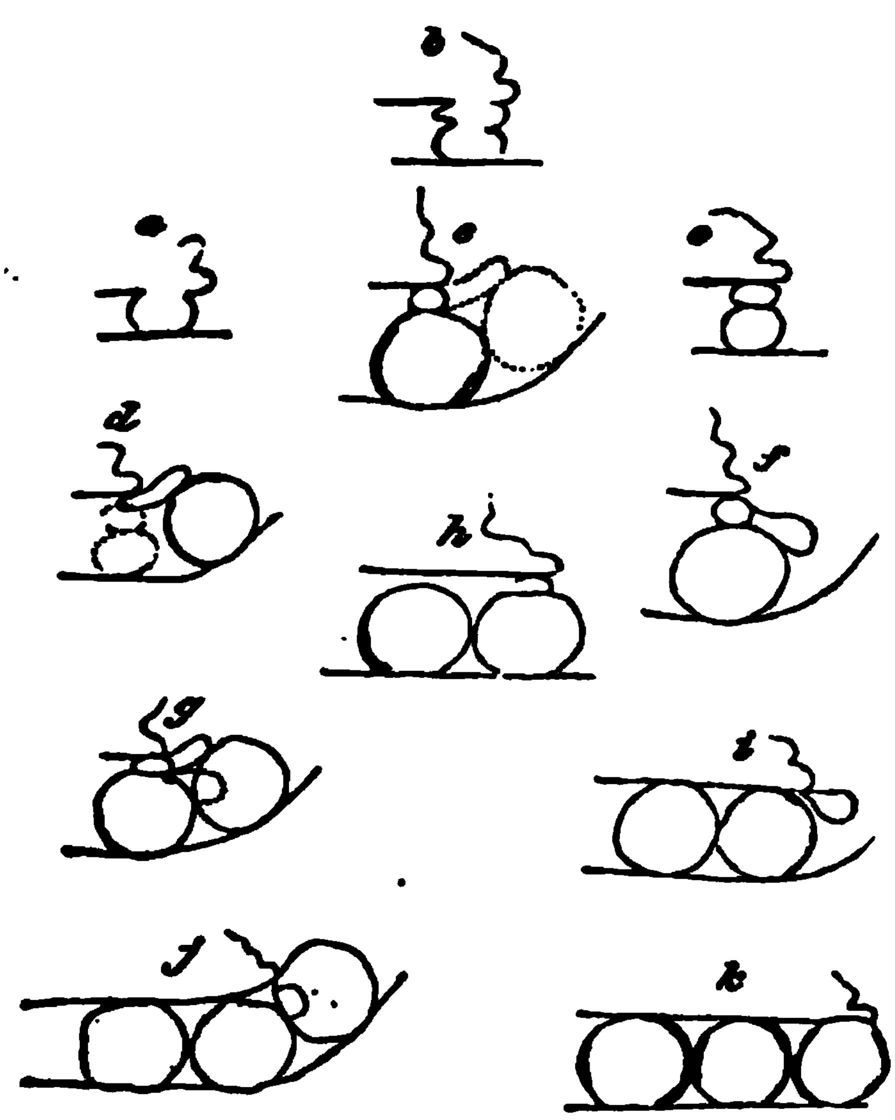
ORIGIN AND DEVELOPMENT OF THE TEETH, AND FORMATION OF THE ENAMEL.

The teeth are appendages of the mucous system, and have their origin from the mucous membrane of the mouth.

FIG. 71: A



B



Mr. Goodsir's observations on this subject being the most minute and accurate, we will very briefly state the result of the facts he has communicated.

His observations began in an embryo as early as the sixth week. At this period the superior maxillary bone, within its external alveolar margin, presents a deep, narrow groove. This he calls the *primitive dental groove*, the mucous membrane lines it. In the seventh week, appears upon its floor a

FIG. 71, A represents the origin and progress of the temporary with the corresponding permanent teeth, after Mr. Goodsir. *a* Mucous membrane, *b* Mucous membrane containing a granular mass. *c* Primitive dental groove. *d* Papilla on the floor of the groove. *e* Papilla enclosed in a follicle. *f* Papilla assuming the shape of a pulp, opercula forming, and reserve cavity seen. *g* Papilla become a pulp and the follicle a sac, from the opercula closing. *h* Secondary groove adherent except behind the inner operculum, where a closed cavity of reserve is left for the pulp and the sac of the permanent tooth. *i* Deposition of tooth substance commencing. *j* Cavity of reserve re-

small *papilla*, which is the germ of the anterior temporary molar. In the eighth week, the papillæ for the canine, in the tenth those for the incisors, and next those for the posterior temporary molars are seen.

This is styled the first or *papillary* stage of development. Delicate processes, passing from the sides of the dental grooves, meet in front and behind the papillæ, so as to form an open *follicle* for each. This is the second or *follicular* stage, which is not completed until the fourth or fifth month. At this period the papillæ begin to change their form into that of the future teeth.

The follicles, which are still open, begin now to be closed, sending from their edges membranous processes across their mouths, called *opercula* or *lids*. Two of these opercula belong to the incisors, three to the canine, and four or five to the molars. The complete formation of these operculæ constitutes the third or *saccular stage*, which commences about the fourth month and continues to the period of eruption—which is another stage called the *eruptive*, and already described in another place.

During the *saccular stage* occur some of the most interesting phenomena in dental growth. At this period the

ceding, and its floor, where the pulp is being formed, dilating. *k* Cavity of reserve becoming a sac, and temporary tooth a layer of bone. *l* Temporary tooth rising to the surface of the gums and getting a fang. *m* Sac of the temporary tooth touching the surface of the gums, and its roots elongated. *n* Sac of the temporary tooth again become a follicle by its eruption. *o* Completion of the sac, and its free portion becoming the vascular margin of the gum, and the "permanent sac connected by a chord passing through the alveolo dental canal or foramen."

FIG. 71, B. *a* Non-adherent portion of primitive dental groove. *b* Papilla and follicle upon the floor of this non-adherent portion, now become a part of the secondary groove. *c* Papilla become a pulp, and the follicle a sac, and cavity of reserve seen. *d* Sac of first molar advancing into the coronoid process or tuberosity of superior maxilla, and increased in size. *e* Sac of first molar having resumed its former position. *f* Cavity of reserve sending backwards the sac of the second molars. *g* Sac of second molar coming into the coronoid process, or tuberosity of superior maxilla. *h* Sac of second molar returned and cavity of reserve shortened. *i* Cavity of reserve sending off sac and pulp of the dens-sapientiæ or wisdom tooth. *j* Sac of wisdom tooth advancing into coronoid process, and tuberosity of the superior maxilla. *k* Sac of the wisdom tooth returned and forming the last of the dental range.

papillæ become pulps, the ivory or dentine and enamel are formed, the enlargement in the maxillary bones, and the ossification of the alveolar processes takes place.

The rudiments of the second or permanent set of teeth are developed soon after the commencement of the saccular period. The papillæ and sacs of the ten milk teeth, in either jaw, are closed about the fourteenth week; and the upper or superficial part of the primitive groove remains open and receives the name of the *secondary dental groove.*

It is in this groove that the permanent teeth begin their development. Behind the operculum of each milk tooth sac a small cavity is seen, called the *cavity of reserve.* The mucous membrane lines this cavity, and on its floor, as in the primitive groove, a papilla is formed which becomes enclosed in a *follicle* and finally in a shut sac; as this is going on, the papilla is found to recede from the surface, and the neck of its sac, which was originally continuous with the common mucous membrane, remains as an obliterated cord connected to the internal surface of the gum of each temporary tooth. These cords are called the *itinera dentium.* About the fifth month the papilla and follicle of the anterior permanent molar is developed in a portion of the primitive groove, which is behind the posterior temporary molar, and is not closed so soon as the anterior portion.

The dental groove, in closing over the sac of this anterior permanent molar, leaves a space between the sac and the gum, which is the *cavity of reserve* for the second permanent molar, and a similar one for the third molar, or wisdom tooth. Owing to the sacs of the anterior permanent teeth, and the temporary ones enlarging faster than the maxillary bones can elongate, the cavity for the permanent molars recedes into the root of the coronoid process below, and into the maxillary tuberosity above. But after birth, as the jaw enlarges, the first permanent molar takes its proper place and level in the dental circle, which is now occupied by the cavity of reserve dilating in it, and developing in it the papilla of the second permanent molar. In

time, as the jaw elongates still further, this molar also descends to its appropriate place; and then the remainder of the cavity behind dilates for the development of the *dens sapientiæ.*

About the fourth or fifth month of intra-uterine life, when the sacculated stage is complete, and the pulps have taken the form of the future teeth, we find the growth of the dentine, or ivory, commencing by being deposited first on the most prominent parts of the surface of the pulp, as on the cutting and grinding surfaces. This we have already explained under the head of dentine.

At birth, and previous to it, each maxillary bone presents, on its border, a whitish and dense tissue continuous with the gum; on raising it, membranous and bony septa, though imperfect, are found between the alveoli; and in the latter are seen, extending from this fibrous, white tissue, prolongations enclosing the dental follicle in a distinct sac, which is perforated at the bottom for the vessels and nerves to enter.

On examination, these dental sacs are found to resemble serous sacs, and to hold some fluid. Their external or parietal layer, being fibro-cellular, is connected with the periosteum, lines the alveolus, and is reflected from the bottom, round the vessels and nerves over the pulp, where it is called the *tunica propria.* It is highly vascular, noticed in the description of the pulp. This reflected portion was originally, in the follicular stage, mucous membrane, which the papilla and pulp, in their ascent and development carry, or push before it.

It has been stated that, on the surface of the pulp, the ivory is first deposited; and that, according to Mr. Nasmyth's discoveries, the superficial set of cells contained in this pulp become elongated, and are first formed into tooth bone; and as these become "calcified," the layer next beneath takes a similar arrangement, is in like manner formed into bone, and so on, layer within layer, till the greater part of the pulp is ossified. In this way a complete shell is formed for the pulp, except where the vessels enter.

The pulp elongates, sending off processes to form the roots, which, in their descent, continue to deposit the ivory around them. During this process, previous to the completion of the outer shell, we have the preparation for the formation of the *enamel.*

FORMATION OF THE ENAMEL.

A diversity of opinion is entertained as to the manner in which the enamel is formed. The doctrine most prevalent at one period, was that the inner membrane of the dental sac made a deposition of the enamel fluid, which by a process of condensation resembling crystallization, ultimately attained the extreme hardness and beautiful polish characteristic of enamel.

The most recent observations, however, seem to prove that there is an especial apparatus provided for this purpose, called by Raschkow, the *adamantine organ*—and by Goodsir, the *granular substance*, which is described as being within the dental sac, and becoming gradually absorbed; and that when the ivory is complete, the interior of this sac is observed to present a "villous and vascular appearance," having a thin layer of this granular substance upon it, which layer is regarded as the *enamel organ* or *membrane*, the matrix by which the enamel is furnished.

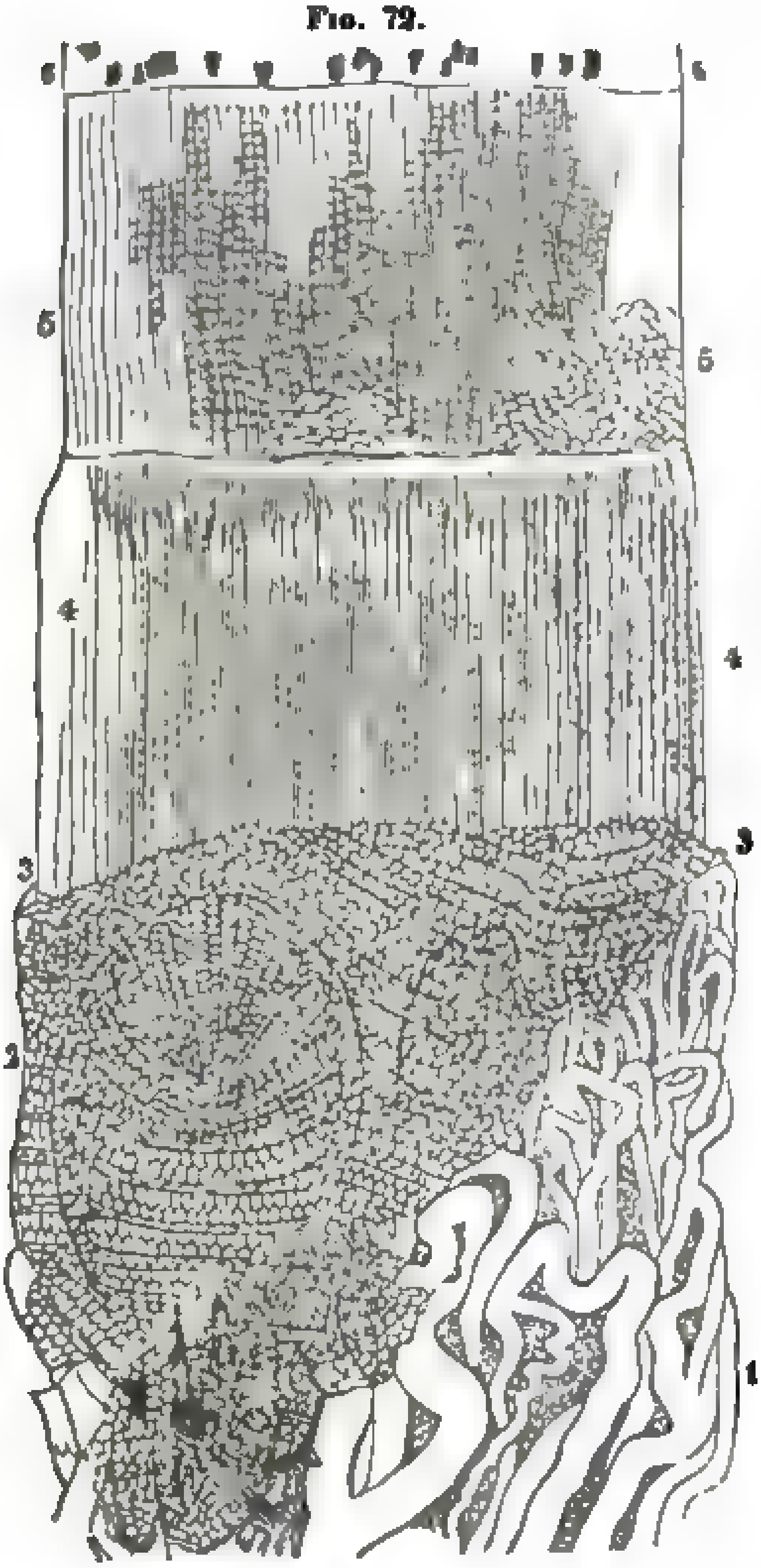
Professor Harris also embraces this view from dissecting the alveoli of a pig, and afterwards those of a "human fœtus at the fourth month," where he, for the first time, saw this granular substance, and was convinced that its office was the furnishing the enamel, and that his previous views were incorrect.*

The microscope of Mr. Nasmyth demonstrates that the enamel, as well as the ivory, consists of cells, and that it is by the calcifying of these cells that the enamel is formed, the deposit being first made on the prominences of the tooth, then over the surface of the crown and body, down to the neck, where it ceases.

* See Harris's Principles and Practice of Dental Surgery.

The enamel is represented as being deposited in minute particles of a calcareous, crystalline character, neither very compact, nor firm, but soon becoming solid and strongly adhering to the surface of the ivory; its fibres being perpendicular to and having a different direction from those of the ivory.

FIG. 72.



We select from Mr. Nasmyth the accompanying figure, which shows all the different structures entering into the composition of a tooth, as the blood vessels, pulp, cells of pulp, their conversion into dentine, enamel, and cementum, at a single glance, and which we have introduced here at the close of their description, in order that a proper estimate may be formed of this gentleman's views of the mode in which teeth are formed.

FIG. 72, 1 1 Blood vessels and capillaries of the pulp. 2 2 Cells in process of conversion into ivory or dentine. 3 3 Line showing the transition of these cells into the structure of dentine more clearly. 4 4 The dentine. 5 5 Enamel. 6 6 Cortical substance or crusta petrosa.

CHANGES PRODUCED ON THE UPPER AND LOWER JAW AND FACE, FROM THE DEVELOPMENT OF THE TEETH.

During the period of the first and second dentition, great and obvious changes are noticed in the face, resulting from changes occurring in the upper and lower jaw bones, from development of the teeth.

The principal of these changes we will briefly notice, to impress upon the student the great and commanding influence which the teeth simply exert during their development, in producing the various configurations of the face, observed at different periods. The first we notice is in the *dental arches*. The maxillary bone, as stated in another place, presents in the first instance a simple groove, scarcely perceptible when the tooth germs are present, but which soon becomes partitioned off and formed into *alveoli* for the accommodation of the two sets of teeth. After the permanent set have completed their eruption, we find but a single range of alveoli; and when, as in old age, the teeth are lost, the alveoli are destroyed and the arches again return to their original embryo state.

The alveolar arches, when the teeth are being developed, show striking changes in their *length* and *height*. The length of the arches depends upon the volume and number of the teeth, and Blandin says it may be safely asserted that the arches grow from the "beginning of life," to the full development of the dens-sapientæ. These arches, in the adult, are separated by drawing a transverse line in front of the first molar, into an anterior and a posterior portion.

All the alveoli belong to the first portion till the appearance of the first permanent molar in the fifth year. The alveolar arch now extends itself back to make room for the second molar and wisdom teeth, and on their appearance, the anterior and posterior portions are of equal length.

The changes in height of the alveolar arches, seem to be regulated by the development of the roots of the teeth.

About the fifth or sixth year, Blandin makes the arches to attain their maximum height; and as we depart from this period, either forward or backward, they "gradually diminish."

The *base* of the *lower jaw* exhibits changes during the development of the teeth; being arched upwards and backwards in the young and the aged, but lying horizontal in the adult. The *angle* of the *lower jaw* is very obtuse in the fœtal and young subject; in the adult it contracts to a right angle; while in old age it again opens, or returns to the infantile state. The *mental prominence*, in the inferior maxilla, is most projecting when the angle is obtuse, as in the young and the aged; while in the nearly right angle of the adult it is much less so. The *condyloid* and *coronoid processes*, instead of presenting the vertical direction of the adult, look backwards and upwards in the child, and the very aged. The coronoid processes in the young, are higher than the condyloid; in the adult, they are nearly on the same level; and in the aged they again return to their early state.

The inferior dental canal does not exist, except in the form of the rudimentary groove, at the earliest periods; it becomes developed when the alveoli are formed.

This canal occupies, in the adult, about the middle point between the alveolar arch, and the base of the lower jaw. It is said to be situated precisely at the lower portion of the alveoli, in the young subject; and in the aged, it is found at the superior border from the loss of the alveoli. In first dentition it is large, and gradually disappears on the shedding of the teeth.

The *anterior dental* or *mental foramen*, according to Mr. Duval, is situated, at birth, near to the symphysis; and in proportion to the development of the teeth, is carried backwards. At first, it is between the canine and first molar. When the milk teeth are fully developed, it is more posterior; and on the appearance of the large molars, it occupies the point between the two temporary molars, or future bicuspids.

The *infra orbital foramen* of the upper jaw presents similar changes. It is found, at birth, to correspond with the point between the canine and first molar; after this, to become more posterior on the completion of first dentition; and when the first permanent molaris appears, to occupy the usual adult point, namely, on a line between the two bicuspids.

The *pterygoid processes* of the sphenoid are also affected, and undergo changes during the development of the teeth. M. Blandin says these processes are to the superior dental arch, what "the posterior border and angle are to the inferior." Both are alike points of support to the alveolar arches; and both also undergo similar changes in the development of the teeth. At birth these processes, like the posterior of the lower jaw, look very obliquely, forwards and downwards. In the adult they take the vertical position; and in old age they again return to their primitive oblique condition.

The *maxillary tuberosity* also undergoes important changes during the development of the teeth. Before the time of their eruption, this tuberosity is large, from lodging the greater molars; but after their appearance, it in a great measure disappears, and still can be seen to exist, notwithstanding M. Blandin's opinion to the contrary.

The roots of the superior middle molars of the upper jaw exert a decided influence upon the floor of the maxillary sinus. In the rudimentary state their action is not very great. But in the adult period, when the sinus is large and the roots fully developed, we sometimes find these roots entering this sinus, a fact of great practical importance in the treatment of its diseases; while, in old age, we are told the sinus, "by a new development, has its floor carried back from the roots of the teeth," whose action upon the sinus is already diminished by the contraction of the alveoli.

Now all these changes upon the upper and lower jaw, during the development of the teeth, it will be readily perceived, must exert a most powerful influence on the

configuration of the face. This is so manifest that we deem any further remarks on the subject unnecessary.

FUNCTIONAL RELATIONS OF THE TEETH.

The relations of the teeth, in their healthy functional action, are varied, and are of great importance. They are, in the first place, the immediate instruments in mastication—a process forming one of the essential and preliminary steps in the function of digestion. By the incisors the food is divided; by the canine it is torn in pieces; and by the molars it is compressed, triturated, and reduced to still smaller fragments adapted to the digestive powers of the stomach.

The teeth also form a wall or hedge, nicely suited to retain the saliva and other fluids in the mouth. They aid in *articulation.* All know how the loss of the teeth affects the pronunciation; how the sounds are less clear and distinct, and speech becomes often fatiguing, difficult, and unintelligible. The incisors are of more importance in articulation than any others; next in order are the canine; and lastly, the molares.

They also conduct impressions to the brain, by transmitting them to the fifth and auditory nerves; and, finally, in some of the lower animals they form the principal weapons of defence, as well as of attack.

The teeth are connected, directly or indirectly, with the whole body, and all its organs and functions. We therefore postpone any further remarks on their relations, till the several organs shall have come under examination.

VARIETIES IN THE TEETH.

These varieties are multiplied, and have been arranged in reference to the *age*, the *individual*, and the *race*.

Under the head of development, much has already been said as to the appearance of the teeth at different ages. We will therefore simply remark, in the language of Mr. Blandin: "In the very young child the crown is formed before the ossification of the root commences. At an age a

little more advanced the crown of the tooth is beginning to wear away before the root is entirely completed. In the adult the crown has lost its points and the root attained its full development. Finally, in old persons, the crown is sometimes completely worn away, whilst the root still remains almost in a perfect state." The destruction of the teeth is therefore regarded as a useful criterion in determining the age.

The *individual* varieties of teeth are numerous, and refer to their number, situation, form, direction, and structure, already treated under the head of *irregularities* of the *teeth*, which see.

The varieties according to *race* are extremely limited. The blacks have them, it is considered, somewhat larger, longer, and more oblique than the white. As to the custom of staining and filing, which some nations adopt, such habits cannot properly be considered under the head of varieties.

SECTION IV.

BLOOD-VESSELS OF THE TEETH. (Fig. 73.)

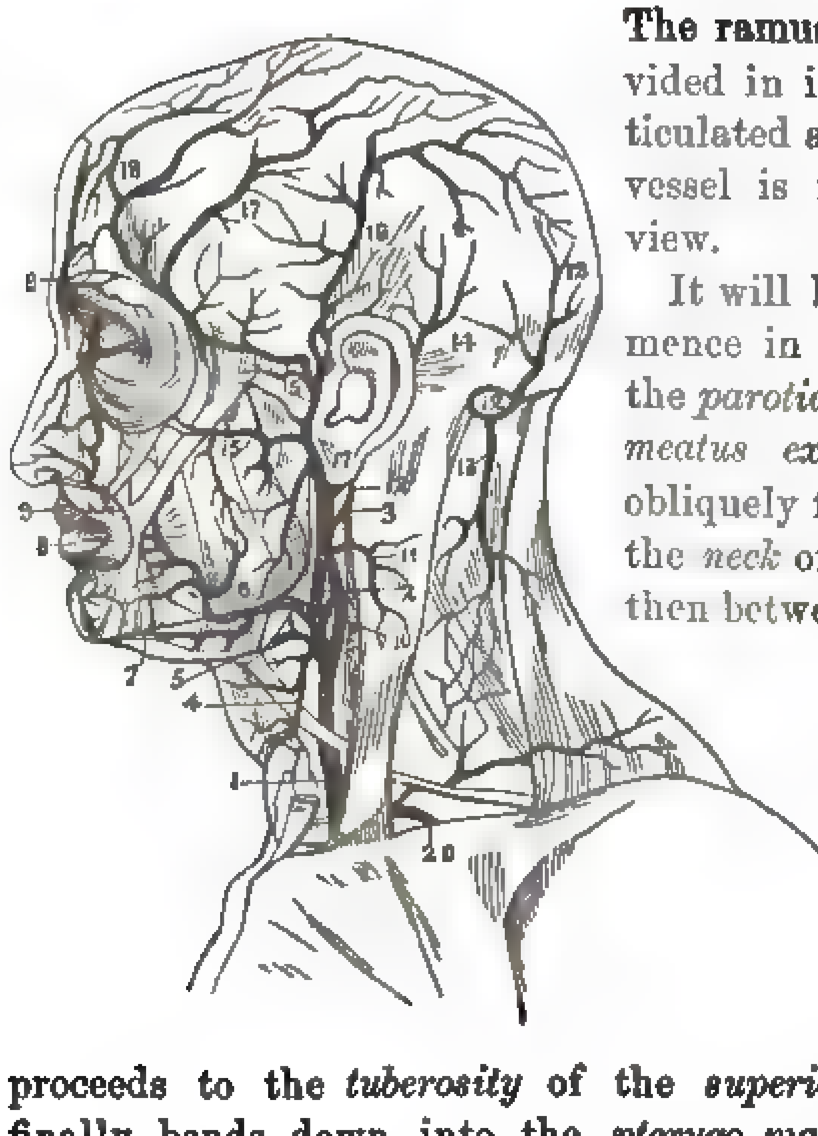
The arteries supplying the teeth come from the *internal maxillary*. This is a branch of the external carotid. The external carotid is one of the two divisions of the common carotid, and extends from the top of the *larynx* to the neck of the *condyle of the lower jaw*, and *meatus auditorius externus*.

It is at the upper part of the larynx or thyroid cartilage that the common carotid arteries make their division into external and internal carotid.

The *common carotids* (καρα, the head, ους, the ear,) arise low down in the neck at its base. The *right common carotid* comes from the *arteria innominata*, the *left* from the *arch of the aorta*. Both ascend the neck, covered first by the *platysma* and *superficial fascia*, along the inner margin of the *sterno-cleido mastoid* muscles, to the top of the *thyroid cartilage*, where, as we have just stated, they divide into the *external* and *internal carotids*.

FIG. 73. A

B



The *external* gives off several branches. The *internal maxillary*, however, is the only one claiming attention in the present place. To expose this vessel, the zygomatic arch should be sawn through at each end, and turned down. The temporal muscle is to be divided at its insertion into the coronoid process, and turned up. The ramus of the jaw divided in its middle, disarticulated and removed, the vessel is now brought to view.

It will be seen to commence in the substance of the *parotid gland*, near the *meatus externus*, to pass obliquely forwards behind the *neck* of the *lower jaw;* then between the two *pterygoid muscles*, often winding round the outer surface of the *external pterygoid* at its origin. From this it proceeds to the *tuberosity* of the *superior maxilla*, and finally bends down into the *pterygo maxillary* fossa, to

FIG. 73, A represents the arteries supplying one side of the face and mouth. 1 1 External carotid artery. 2 Inferior maxilla with its exterior wall removed, so as to expose the inferior dental artery, and roots of the teeth.

terminate by sending off several branches. Its branches supplying the teeth are,

1. The superior dental or alveolar.
2. Infra orbitar.
3. Inferior dental or maxillary.

The *superior dental artery* comes off from the internal maxillary, at its entrance into the *pterygo maxillary fossa;* it then winds round the *maxillary tuberosity*, sending branches through the *posterior dental canals* to supply the *molares* and the *antrum*, and finally proceeds forward upon the alveolar processes, supplying their cavities, and the gums. Those branches going to the teeth enter by the foramen at the apex of the roots, and are distributed over the pulps.

The *infra-orbital artery* arises from the internal maxillary in the upper part of the *pterygo maxillary fossa*, enters the *infra orbital canal*, traverses its whole extent along with a nerve of the same name, and emerges upon the

3 Posterior mental foramen, which gives passage to the inferior dental artery. 4 Anterior mental foramen, where the same artery makes its exit. 5 5 The anterior and inferior wall of the superior maxilla removed, so as to exhibit the antrum, roots of the teeth, and arteries supplying each. 6 Infra-orbitar foramen, for the passage of the infra-orbitar vessels. 8 Nasal process of superior maxilla. 9 Pterygoideus internus muscle. 10 Angle of inferior maxillary bone. 11 Orbit of the eye. 12 Superior thyroid artery. 13 13 Facial artery. 14 Terminating branch of the lingual. 15 Where the external carotid terminates by dividing into the internal maxillary and temporal. 16 Temporal artery. 17 Internal maxillary. 18 18 Inferior dental artery. 19 Deep temporal branch. 20 Transverse artery of the face. 21 21 Muscular branches. 22 Alveolar branch. 23 Posterior dental branch. 24 Where the infra orbital artery terminates. 25 Nasal branch of the facial. 26 Sub-mental branch.

Fig. 73, B represents chiefly the external carotid artery, and its branches which supply the exterior head, face, and part of the neck. 1 Common carotid artery. 2 External carotid. 3 Internal carotid. 4 Superior thyroid. 5 Lingual. 6 Facial branches of external carotid. 7 Sub-mental. 8 Inferior coronary. 9 Superior coronary branches of facial. 10 Occipital. 11 Inferior pharyngeal branches of external carotid. 12 12 13 Branches of occipital. 14 Posterior-auricular branch of external carotid. 15 Transverse facial. 16 Posterior temporal. 17 Middle temporal. 18 Anterior temporal branches of the temporal artery. 19 Supra orbitar, a branch of the ophthalmic. 20 Subclavian, a branch of the arteria innominata on the right, and the aorta on the left.

face at the *infra orbital foramen*, anastomosing with the facial and transverse facial arteries. Just before it emerges, it sends down, in the anterior dental canal, a branch to supply the incisors and cuspidati, and also the lining membrane of the antrum.

The *inferior dental* arises from the internal maxillary behind the neck of the lower jaw, descends to the *posterior mental foramen*, which it enters along with the dental nerve; thence it passes along the canal beneath the roots of the teeth, sending up into each, in its course, small twigs which supply the *molars*. When opposite the *bicuspid*, it divides into two branches—the one being the continued trunk which proceeds forwards to the symphysis, supplying the anterior teeth, while the second branch passes out at the anterior mental foramen, upon the side and front of the chin, anastomosing with branches of the facial artery.

The *internal maxillary vein*, made up of the veins corresponding to the several branches of the internal maxillary artery, returns the blood of the artery, and passing behind the neck of the jaw, unites in the substance of the parotid with the temporal vein—the junction of the two mainly forming the *external jugular*, which passes superficially down the neck, to terminate in the subclavian vein.

THE NERVES OF THE TEETH. (Fig. 74.)

The nerves supplying the teeth come from the fifth pair, and are nerves of sensation. The fifth nerve can be traced to the spinal cord, having its roots in the anterior and posterior columns; hence it is called the cranial-spinal nerve. Being a spinal nerve, it has on its posterior root a ganglion, and the junction of the anterior and posterior roots constitutes properly the fifth nerve. It is seen to emerge at the side of the *Pons-varolii* on the anterior part of the *crus-cerebelli*. At this point it is composed of from 80 to 100 filaments, which pass forward in a canal of the dura-mater upon the anterior surface of the petrous bone, in a depression of which it expands into a ganglion called the *Gasse-*

rian ganglion. On the under surface of this ganglion is seen the anterior root, having no connection with it and being the motor portion.

From the gasserian ganglion proceed three branches,

1. The ophthalmic,
2. The superior maxillary,
3. The inferior maxillary nerve.

The two latter furnish the branches supplying the teeth. The *superior maxillary* nerve arises from the middle of the ganglion of Gasser, passes forwards through the *foramen rotundum* of the sphenoid bone, into the pterygo-maxillary fossa—at this point it sends off several branches, two of which descend to join the *ganglion* of *Meckel.* The main trunk is continued forward with the artery in the *infra orbital canal,* as the *infra orbital nerve,* and finally emerges at the *infra orbital foramen* between the levator labii superioris alæque nasi, and levator anguli oris muscles, anastomosing with the nasal branch of the ophthalmic, and the portio-dura of

FIG. 74.

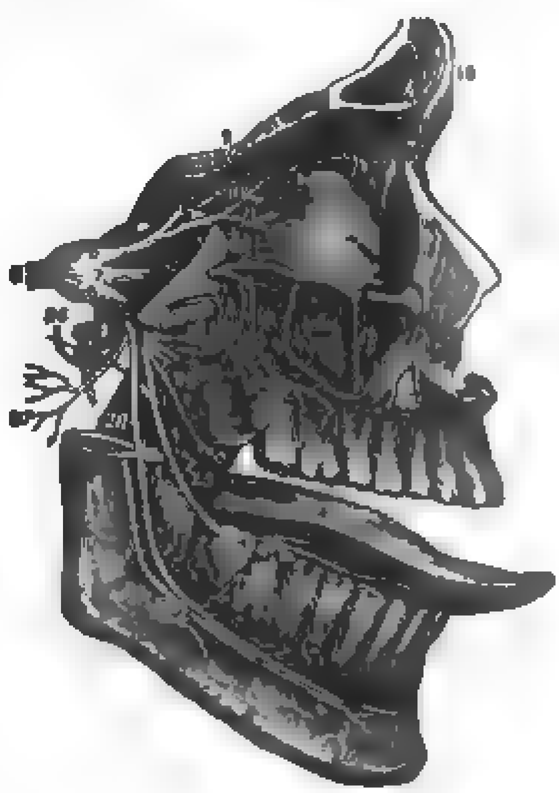


FIG. 74 represents the distribution of the fifth pair, or Trifacial Nerve, and especially those branches supplying the teeth.

1 Orbit; 2 Maxillary sinus, or antrum of Highmore; 3 Tongue; 4 Inferior maxilla; 5 Root of fifth pair, forming the ganglion of Gasser; 6 Ophthalmic, or first branch of the fifth; 7 Superior maxillary, or second branch of the fifth; 8 Inferior maxillary, or third branch of the fifth; 9 Frontal branch; 10 Lachrymal branch; 11 Nasal branch, which latter, with 9 and 10, are branches again of the first or ophthalmic division of the fifth; 12 Internal nasal nerve going through the anterior ethmoid foramen; 13 External nerve; 14 External and internal frontal nerve; 15 Infra orbitar nerve; 16 Posterior dental nerves; 17 Middle dental branch; 18 Anterior dental

the seventh. The infra orbital nerve, just before emerging, sends down in the anterior dental canal, in front of the antrum, the *anterior dental nerve,* which gives off filaments to supply the incisors, canines, and bicuspids of the upper jaw, as well as the lining membrane of the antrum. These accompany the arterial twigs and enter the apex of the roots in a similar manner. An anastomosis occurs between the anterior and posterior dental nerves. The *posterior dental nerves* come off from the superior maxillary in the pterygo maxillary fossa; they consist of two or three branches, which enter the posterior dental canals upon the tuberosity of the superior maxillary bone, and supply the molares, the contiguous gums, and buccinator muscle.

The superior maxillary nerve is connected with the ganglion of Meckel, called also spheno-palatine, from which three sets of branches are found to proceed—the one passing downwards, the *inferior,* the second going backwards, the *posterior,* while the third proceeds inwards, and is the *internal* set.

The *ganglion* of *Meckel* is situated in the pterygo-maxillary fossa between the pterygoid processes and the tuberosity of the superior maxilla, surrounded by adipose matter and branches of the internal maxillary artery. The first set of branches, the inferior, proceeding from this ganglion, descend the posterior palatine canal. They are four or five in number and receive the name of the *palatine nerves.* As they approach the palate they divide into an anterior, posterior, and middle set of filaments; the anterior proceeds forwards above the mucous membrane in a groove on the inside of the alveoli, supplying these parts, while the posterior and middle are distributed to the soft-palate, tonsils, and uvula.

nerve; 19 Terminating branches of infra orbital; 20 Orbitar branch upon the malar bone; 21 Pterygoid branches from Meckel's ganglion; 22 Anterior branches of the inferior maxillary, or third division of the fifth; 23 Lingual or gustatory branch of the inferior maxillary, joined by the chorda tympani; 24 Inferior dental nerve, and branches supplying the teeth; 25 Mental branches; 26 Superficial temporal nerve; 27 Auricular branches; 28 Mylo-hyoid branch.

The posterior branch, called the *pterygoid* or *vidian*,* passes from the ganglion of Meckel in the backward direction, through the vidian canal at the root of the pterygoid process, then enters the cranium through the foramen lacerum medius, and divides into an *inferior* and *superior* branch. The former, called the *carotid branch*, enters the cavernous sinus and unites with the plexus surrounding the carotid artery, formed by the ascending branches of the superior cervical ganglion. The *superior branch* represents rather the continued trunk of the vidian, and

* Very great confusion of description and wide diversity of opinion prevail among anatomists in regard to this nerve and its connections. By some it is regarded as a sensory nerve, coming off from the fifth pair. By others it is considered as a sympathetic nerve originating from Meckel's ganglion, and binding together the various superficial and deep nerves of this region.

Before its entrance into the *hiatus fallopii*, it is found to connect itself by filaments with many nerves at the base of the skull, entering the *hiatus*. It is ordinarily described as uniting with the facial at its angle, where the *intumescentia genuformis* (or *gangliformis*) is found. The researches of Morganto, Brinton, and Malagati, show that this intumescence does not belong to the facial, but to a third division of the old seventh nerve, first described by Misberg, and called by him *portio intermedia*, because it lies between the facial and auditory nerves. It is clearly traced into the medulla oblongata in one direction, and into this geniculate ganglion in the other. Malagati infers from his recent investigations that this *portio intermedia* is really a nerve of organic life, entering the brain, and associating the ear with that viscus as well as with the viscera of the thorax and abdomen—a theory which accounts for the remarkable sympathies known to exist between the ear and these various organs, how it is with this *geniculate ganglion*, that the superior branch of the vidian (*nervus petrosus superficialis major* of Arold) is connected. With it also is joined the *nervous petrosus superficialis minor*, which may be regarded either as a branch of the optic ganglion, or of the tympanic plexus. In any case, however, it connects the *glosso-pharyngeal* with this petrosal branch of the vidian, through the medium of *Jacobson's nerve*.

From this same geniculate ganglion, which thus appears to be a highly important sympathetic centre, the *chorda tympani* comes off, and, as described in the text, passes through the Glasserian fissures and unite itself with the gustatory branch of the fifth pair. It seems to exercise an influence upon the sense of taste; for impairment of this function always occurs when the facial is injured, when its injury can involve those of the *chorda tympani*.

The termination of the *chorda tympani* has been stated according to the views of the English anatomists. It cannot, however, be wholly traced into the submaxillary ganglion. Some anatomists have failed entirely to establish the connection. Guarini traces it into the lingualis muscle. At most, only a portion of the nerve can be connected with this ganglion.

passes beneath the ganglion of Gasser and the dura mater, outwards and backwards upon the anterior cerebral surface of the petrous bone, to the *hiatus fallopii*, which it enters. In this canal it joins the portio dura, and accompanies this latter nerve to the posterior part of the tympanum, where it then leaves the portio dura by entering the cavity of the tympanum, and here receives the name of *chorda tympani.* Its entrance into the tympanum is below the pyramid, and from this point it crosses the cavity between the long leg of the incus, and handle of the malleus; then it emerges along with the tendon of the laxator tympani muscle by the glenoid fissure, and now runs forwards and inwards, joining in its course the gustatory nerve as far as the submaxillary gland, at which point it joins the submaxillary ganglion. This ganglion is found at the posterior part of the submaxillary gland.

The vidian nerve, by this lengthy and circuitous course, establishes, says Mr. Harrison, several very interesting relations: by it, the ganglion of Meckel, the superior cervical ganglions of the sympathetic, and the submaxillary ganglion, are all connected. It also unites the superior and inferior maxillary nerves, and both to the portio dura.

The third set of branches from Meckel's ganglion pass inwards, and are called the *nasal* or *spheno-palatine.* These (often only a single branch) pass through the spheno-palatine foramen and then separate into five or six branches, which supply the mucous membrane of the upper and middle spongy bones. One long branch, called the nerve of Cotunnius or naso-palatine, is seen to descend along the septum-nasi as far as the foramen incisivum, at which point it meets the anterior branches of the palatine nerves, and also here a small ganglion is spoken of, but difficult to be distinguished.

An *orbital* branch comes off next from the superior maxillary, this gets into the orbit through the spheno-maxillary fissure, and there divides into a temporal and a molar branch. The former is traced through the malar bone into the temporal fossa, accompanies the temporal artery, and

is spent upon the side of the head and temple; the malar branch also passes through the malar bone and is distributed to the muscles and integuments upon this bone.

The inferior maxillary nerve forms the third and largest division of the fifth. It arises from the lower portion of the Gasserian ganglion, passes through the foramen ovale of the sphenoid bone, and as it leaves this foramen unites with the motor root, and then divides into two branches, an external or superior, and internal or inferior.

The inferior gives off the branch which supplies the teeth of the lower jaw. This is the *inferior dental nerve.* It separates from the gustatory nerve, and descends between the pterygoid muscles, along the ramus of the lower jaw to the *posterior dental foramen* into which it enters. It now proceeds along the canal in the inferior maxillary bone, supplying the teeth in its course to the anterior dental foramen through which it emerges, and is distributed to the muscles and integuments of the lower lip and chin; at this latter foramen a small branch is continued forward, the *incisive branch,* to supply the incisor teeth.

The *mylo-hyoideus* is the only branch generally given off by the inferior dental nerve. It comes off at the posterior dental foramen and passes along a groove on the inferior maxillary bone, to the mylo-hyoid and digastric muscles.

The *gustatory* is the next in size of the internal or lower division of the inferior maxillary. It connects with the inferior dental, and is joined by the chorda-tympani soon after this junction. It descends between the *ramus of the lower jaw* and the *internal pterygoid muscle;* proceeds obliquely forwards above the *submaxillary gland* and *mylo-hyoid* muscle, accompanied by the duct of Wharton, and is distributed to the lateral and anterior parts of the tongue. The gustatory gives off, in this course, filaments to the *pterygoideus internus,* the *pharynx, tonsils, muscles of the palate* and the *gums,* as well as communicating branches with the lingual.

The *auricular* is the smallest branch of the inferior division, it passes posterior to the neck of the lower jaw and in

front of the meatus externus, supplying the *articulation of the jaw*, the *meatus auditorius*, the *cartilages of the ear*, and then mounting over the zygoma, divides into *anterior* and *posterior* branches, which follow the course of the *temporal artery*. This nerve connects with the *facial*. The superior division of the inferior maxillary nerve has the motor trunk and divides into the *masseter*, the *deep temporal*, the *buccal*, and the *pterygoid* branches.

The *masseter* nerve passes in front of the neck of the lower jaw and the insertion of the temporal muscle, through the sigmoid notch, and is distributed to the masseter muscle. The *deep temporal nerves* ascend to the temporal muscle, in which they are lost. They are two in number, an *anterior* and a *posterior*.

The *buccal* nerve goes between the pterygoid muscles, giving some filaments to these, and is then distributed upon the buccinator, forming a plexus upon this muscle with the infra-orbital and the facial. The *pterygoid* nerve consists of two or three branches, which go to the pterygoid muscles.

SECTION V.

COMPARATIVE ANATOMY OF THE TEETH.

The examination of similar organs in the inferior animals, has always been a subject of deep interest and close study to the anatomist and physiologist, and always regarded by them as essential to the full understanding of the structure and functions of the various organs of the human body—to the full development of medical science.

What is true of the body, as a whole, applies with equal force to its several parts. Each organ finds its analogue in some one or more of the inferior animals; and the teeth, as forming parts, and indispensable parts, of the human frame, come in equally for their share of examination, in this comparison of organs, among the inferior animals.

The importance of this subject has now fully aroused the master spirits of the profession to investigation in this

department of scientific and practical research; and their labors have already been crowned with the most useful and happy results.

Cuvier and *Owen*, with many others, have shown that the teeth of all animals obey the same fixed and immutable law of *limitation* in their form, size, structure, function, and duration—in a word, that all the essential elements of their organization are obedient to, and governed by the same general laws. Still further, the teeth are now regarded as forming the most secure basis for classifying the animal kingdom; for every class of animals having the *form* of its teeth differing from that of every other class, we readily recognize the distinction, and obtain a foundation of classification superior to any other—while from the great durability of these organs, and their superior resistance to the process of decomposition, the geologist is furnished with a key by which he can unlock the history of the past, and testify, not simply of the existence of animals long since extinct, but accurately classify, and faithfully describe their habits, food, and other peculiarities. To the dental student, therefore, an acquaintance with comparative dental anatomy, as far as his opportunities will allow, becomes a matter of great interest, and should always hold a high rank among the various studies pertaining to his profession.

We do not, by any means, however, intend to enter into any lengthy detail on comparative dental anatomy; for such an attempt would be entirely incompatible with the limits of the present work, as well as altogether unnecessary since the publications of Owen, Blandin, and others. All that we propose here, is simply to give such a general outline as may induce every student to examine the subject for himself, and so to estimate the value of such knowledge as to be persuaded to devote all, or as much of his leisure moments as he can spare to its study and investigation.

The *extent* of the dental organs proper seems to be limited to the vertebrated division of the animal kingdom, or

confined to those possessing a spine. In the invertebrata, instead of true teeth, the parts answering this purpose are rather horny or calcareous indurations.

The class *mammalia*, with but few exceptions, have teeth; and, according to M. Geoffroy, St. Hilaire, some animals which appeared to be entirely without them, were found to possess them during a portion of their life.

Every tooth in the human subject consists naturally of a crown, neck and root; but this division does not apply to all the mammalia, for the incisors of the rodentia, and the tusks of the elephant, are covered with enamel over their whole extent, and are hence said to be without roots. This distinction is, however, not considered good, since portions of these teeth are imbedded like the roots of all others in alveolar cavities.

The teeth of the mammalia are divided into "simple compound, and semi-compound or mixed."

Like the human teeth, the simple have no "anfractuosities" on their outer surface. The crown consists of a regular shell of ivory, covered with a smooth and even layer of enamel.

The compound teeth, on the other hand, look like several teeth joined together, as they have their surface presenting such deep sinuosities, and the cavity of the compound tooth has as many subdivisions as there are parts joined together. "A good idea," says M. Cuvier, "of the compound teeth of animals may be drawn from the human molar teeth, which have a simple crown and compound root, whilst the former have generally a simple root and compound crown. Suppose the roots of the large human molars, covered with enamel and joined together by cement, and you have a type of the compound teeth of other mammalia."

The teeth of the mammalia are also divided, like the human teeth, into the *deciduous* or *milk*, and the *permanent teeth*. The number of teeth in this class varies very much, though less than in the other vertebrata. The highest number is stated to be 190, and only to be found in the *dolphin*. The *form* of the teeth constitutes the especial

mark of distinction among the different mammalia. They are all received into proper alveolar cavities, supported by and contained within the maxillary or intermaxillary bones. The teeth of mammalia are also distinguished from those of man by their varied conformation, especially of the crown, which is asserted to differ as widely as the food upon which they each respectively subsist Those of the carniverous and ferocious class, which feed on flesh for example, have crowns with much stronger prominences, and more pointed and cutting edges, while those on the other hand which live on vegetable food, and are peaceable in their disposition, have flat and large crowns.

The human teeth come between these two extremes, and partake of the characters of both, and hence it is that man is regarded as an omniverous animal, his teeth being adapted to living on both animal and vegetable diet.

The teeth of the lower *mammalia* consist, as in man, of ivory and enamel, and they are arranged in similar manner. The animals, however, have a substance called *cement*, or, as Tenon terms it, the "*osseous cortical substance;*" which, though existing in human teeth, is by no means so abundant or extensive.

The cement is harder than the ivory, but not so hard as enamel. It blackens sooner, on exposure to heat, than the latter, showing that it contains a greater amount of animal matter. It is said to be so abundant in the grinders of the elephant, as to form about half their volume. Its mode of formation is not settled: some think it is the ossification of the internal membrane of the follicle—others, with Cuvier, that the same organ which secretes the enamel, after it is formed, then furnishes the cement. The chemical analysis of cement is given as follows:

Animal matter,	43.01
Phosphate of lime,	52.94
Carbonate of lime,	4.05

The *duration* or *period* of *growth* in the teeth of man and mammalia varies, so much so that in the statement about

to be made, the law of fixed limitation in the growth of all organs would seem to have some exceptions. The *rodentia*, *pachydermata*, and *cetaceæ*, are cited as instances of unlimited growth of the teeth, and such indefinite growth as is confined, almost in all cases, to the incisors or canines. The cause of this constant growth of these teeth during life, is thus given by M. Blandin: "These teeth," he says, "are classed with those which have no roots; their internal cavity is conical in form. The pulp, conical also, rests, by a large base, upon the bottom of the alveolus, whence it receives its vessels and nerves, and not through the medium of a pedicle.

"In consequence of this arrangement, it is evident that the bony matter can never surround the pulp in such a manner as to interrupt its functions; and there is no reason," he then adds, "why it should not continue to secrete this substance during life."

The *order* in which the teeth of mammalia make their appearance, is the same as in man, i. e. from before to the back part of the mouth. The *number* of dentitions in some of the mammalia is not limited as in man. The elephant, it is found, has its molars renewed as many as eight times.

This frequent renewal of the teeth, it seems, is regulated in proportion to the life of the animal, as to whether long or short, and there are but two ways in which the animal can be kept supplied with teeth, either to replace by a new set when the present ones are lost, or by constantly adding new matter to the base of those already formed, as fast as they are destroyed by friction on their upper surface. The teeth are liable to be *worn* away from friction, some more than others, as the back teeth of the elephant are not so much worn as the front. The kind of food seems to exert a special influence in this wearing away; those that live on grass and nuts, as the *gramenivora* and *rodentia*, have distinct lines on their cutting and grinding surfaces, and the direction of these lines indicates the direction of the teeth in the mastication of the food. In the ruminantia the lines are transverse, showing that the friction is from side

to side, while in the rodentia they are antero-posterior, showing the friction to be from front to back.

In the *carnivora*, on the other hand, or those that live on flesh, there is very little wearing away of the teeth, scarcely any lines from friction to be seen, and the points and cutting edges are preserved to the end of life. This inequality in the wearing of the teeth has been turned to practical account in determining the age of the horse, and the incisors are those by which the age is known. "The middle teeth, says M. Cuvier, begin to appear about fifteen days after birth, and at two years and a half the middle ones are replaced; at three and a half the two next follow, and at four and a half the outermost or corner teeth. All these teeth with originally indented crowns, lose by degrees this character by detrition. At seven and a half or eight years the depressions are completely effaced, and the horse is no longer marked. The inferior canines appear at three years and a half, the superior at four years. They remain pointed until the sixth, and at ten begin to peel away." The horse seldom lives longer than thirty years.

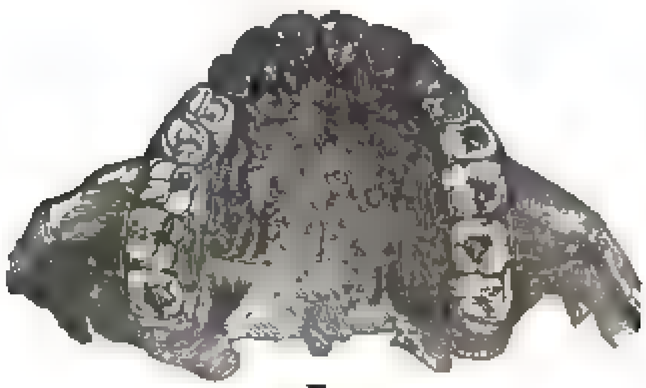
With these general remarks, we will now proceed to run a very brief contrast between the teeth of the different orders of the class *mammalia* and those of man, commencing with the highest in the scale and then descending. The first *order* is the

QUADRUMANA.—This order is divided into the *monkeys*, *simiæ*, and *lemurs*. The *chimpanzee* and *ourang-outang* constitute the highest order of monkey, and are next to man in their organization. According to Mr. Owen, the most prominent points of distinction between the dentition of man and that of these higher quadrumana, consist in the "absence of the interval between the upper lateral incisor and the canine in man, and the comparatively small size of the latter tooth." (Fig. 75.)

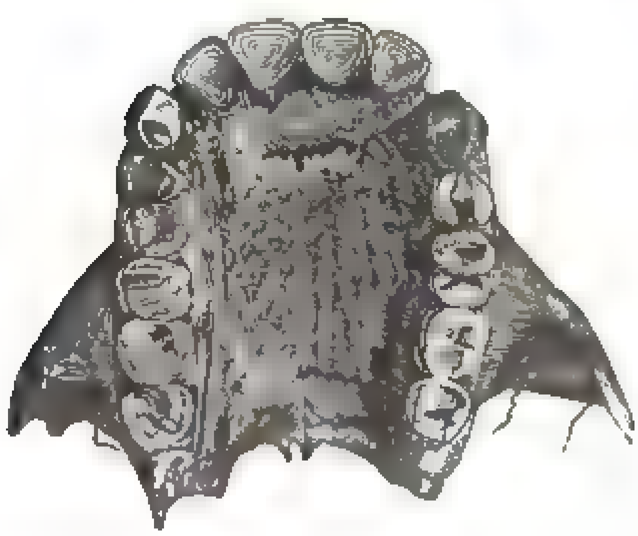
The human teeth are more equal in size, and describe a more regular curve in both jaws, and do not, as just stated, present the vacant space of the monkey. The incisors of the human teeth are smaller in proportion to the

molars than those of the *chimpanzee* or *orang.* The upper and lower bicuspids are also smaller in proportion to the molars, than those of these animals.

Fig. 75. A



B



In the human teeth the crowns of the true molars are observed to be larger in proportion to the bicuspids, still larger in proportion to the canines and incisors, and larger in proportion to the jaws, and have the borders of their grinding surface more round than is found in the chimpanzee and orang. When the permanent teeth appear, it is remarked that the first true molar in both upper and lower jaw is "much more worn," in comparison with the other molars, than in the chimpanzee and orang, in consequence of the longer time which elapses between the appearance of the first and last true molars of the human teeth and those of these animals, and consequently the greater amount of friction the first molars are subject to.

The number of teeth in these quadrumana is the same as in man. The deciduous set are the same in number. The following contrast between the human deciduous teeth and those of the chimpanzee and orang, is from the pen of Mr. Owen.

"The upper milk incisors of the chimpanzee," he says, "are relatively larger than in man, especially the middle pair, but the disproportionate size of these is still more man-

Fig. 75, A represents the superior dental arch of man.
Fig. 75, B represents the superior dental arch of a chimpanzee.

ifest and characteristic of the orang, and the outer angle of the lateral incisors is more rounded off in this quadruman. The crown of the canine is longer and more pointed in the chimpanzee than in man; still more so, and farther apart from the incisor, in the orang. The first molar is as large in the human subject as in the chimpanzee, and its crown is divided into two principal cusps, but the outer and larger one has a small subdivision notched off posteriorly, and the inner cusp is relatively larger than in the chimpanzee. The first upper molar of the orang is simply bicuspid, but is larger than in the chimpanzee. The second molar of the human child could scarcely be distinguished from that of the young chimpanzee, both are quadricuspid, and the same oblique ridge crosses the grinding surface from the antero-internal, to the postero-external tubercle, but the pointed summits of the two outer cusps are a little more extended in the chimpanzee. The second molar of the orang, besides its larger size, has the four tubercles better defined, and the oblique ridge less developed.

"The lower deciduous incisors of the *anthropoid apes* differ from those of the human subject in their superior size, greater relative thickness, and the lateral incisor more particularly, by the rounding off of the outer angle.

"The lower canine of the chimpanzee has a larger, longer, and more pointed crown, with a sharp posterior edge; this is less marked in the canine of the orang, which is larger and thicker than in the chimpanzee; the crowns of the upper and lower canines are more obliquely opposed, the lower one being more advanced in those apes than in the human subject.

"The first lower deciduous molar of the human subject has four tubercles and a small anterior ridge, and is larger than that of the chimpanzee, which supports a single large pointed cusp and a posterior ridge. The first molar of the orang has a similar simple crown, but is as large as that of the child. The second molar is of equal or superior size in the human subject to that in the chimpanzee, but it supports three outer and two inner cusps, while in the

chimpanzee it has but four cusps; in the orang, the fifth external and posterior tubercle is feebly indicated. The deciduous molars of the human subject, as in the chimpanzee and orang, have each three fangs in the upper and two in the lower jaw."

In the order of *succession* in the teeth of these quadrumana and man, there is some difference. It has already been stated, in the description of human dentition, that the first true molar and first incisor are the earliest to appear in the permanent set; and between these two points, Mr. Hunter remarks, the teeth progress more rapidly than those behind.

But in the quadrumana this is not the case, and the progress is slower; for in these the second molar is found to precede the bicuspid, and the last molar the canine. And the cause of this difference is assigned to the difference in the food. Monkeys, living on fruits and meats, require the use of their grinders at an earlier period than either the canine or incisors. In the *baboons* and *mandrills*, which are a step lower than the monkey tribe, we find their dentition most especially distinguished from the human, by the canine teeth presenting the ferocity and strength of the carnivorous animals. Those of the mandrill are described as "weapons most formidable for their size and shape," the upper canines especially, which pass behind the crowns of the lower incisors, and on the outside of the first lower bicuspid, which seems pressed back, as it were, by the action of the upper canines. A considerable space divides the upper canine from the incisors—a shorter one separates it from the bicuspid. The first bicuspid of the lower jaw is distinguished by the base of its crown having an unusual anterior prolongation, which is reduced to a cutting edge by the friction of the upper canine.

The class of *lemurs* are the lowest in the scale of the *quadrumana*, and differ from these in their dentition, as well as from the human race, by having thirty-six teeth instead of thirty-two; the difference being in the bicuspids, of which these animals have six to each jaw, three on

either side instead of four, as in man and the higher monkey.

The two incisors of the upper jaw are separated by a wide space from the two on the left, and are small, vertical, and have their crowns short and expanded.

The canine is long, compressed, and curved, with its edge sharp and pointed. The three bicuspids present, on the inner side of their crowns, a tubercle, while on their outer there is extended a compressed and pointed lobe.

Both jaws have their first true molars the largest. The first bicuspid, in the upper jaw, has its two roots connate or joined together; those of the other two are distinct. The roots of the upper molars, as in the human teeth, are three in number; but in the lower jaw, both bicuspids and molars have only two roots. The number of deciduous teeth in the lemurs is twenty-four, instead of twenty, as in man—the excess being in the molars. Among the quadrumana there are two genera described, which are most remarkable for their very singular and anomalous dentition. They consist of the *galeopithecus* (the weasel-like monkey) and the *cheiromys*.

The former are said to resemble the bat, in having a kind of wing, formed of a fold of the integument, reaching from the front to the hind extremity, and may be called flying monkeys.

The teeth in this genus are thirty-four in number, i. e. four incisors in the upper jaw, two on either side, and six in the lower jaw, three on either side, making ten incisors in all—two more than in man. The two anterior upper incisors have a wide space between them, are very small, and have their crowns expanded and presenting three or four tubercles. The second incisor of the upper jaw, which is said to be connected with the intermaxillary bone, has one very striking peculiarity in having two roots. Its crown is of a triangular shape, having, at the front and posterior base, a small talon—also dentations, two anterior and three posterior, at the same points.

The upper canine has, very unlike the human, two roots.

The first upper biscupid has its crown of a trihedral shape. The second bicuspid has a pointed talon at its base.

The crowns of the first two incisors of the lower jaw present a very peculiar arrangement in the form of a comb. This tooth-like or pectinated appearance, is compared to the little notches on the edge of "a new-formed human incisor," though the serrations are much deeper and more numerous. These teeth have a single root. The third incisor is thought to resemble a canine, though its crown is described as being broad, horizontal, and having four shallow notches on its margin; this tooth, also, has a single root. The lower canine, like the upper, has two roots. The milk teeth are twenty-two in number—ten to the upper jaw, and twelve to the lower.

In the *cheiromys* a resemblance is traced to the rodentia, in the chisel-like incisors of both jaws, which make but a single pair, and are large and curved. The canines are *wanting*, and a wide space separates the incisors from the molars.

As the cutting edge of the teeth below does not strike against the "posterior ridge" of those above, M. Blainville supposes that the chisel teeth of the incisors have a different use from those of the rodents, and that the cheiromys employ them as "cutting pincers to remove the bark of trees, in search of larvæ or insects," though the flat, smooth crowns of the molars would seem to show their food not to be entirely of this character. The upper jaw has four molars on each side, and the lower three, placed vertically and parallel. The first upper molar is the smallest, and the second the largest of that jaw. In the lower jaw the last molar is the smallest. A striking contrast with the human molar exists in the roots. In the cheiromys the first and last molars of the upper jaw have but one root; the two middle have each three roots. In the lower jaw the first molar has two roots, the other two but one.

INSECTIVORA.—This order is regarded as the transition step between the quadrumana and carnivora. The different genera are remarkable for the varieties in their teeth,

in number, shape, and size. The most common characteristic found to prevail is the presence of "several sharp points upon the crowns of the true molar teeth."

This order is divided into the families of *moles* (talpidæ), *shrews* (solicidæ), and *hedge-hogs* (erinacidæ.)

The mole of the cape, as it is called, according to Mr. Owen, has forty teeth. Its dental formula is to the upper jaw on either side, three incisors, one bicuspid, and six molars; to the lower jaw, three incisors, two bicuspids, and five molars. The American mole has thirty-six teeth: to the upper jaw, on either side, three incisors, one canine, three bicuspids, three molars; to the lower jaw, two incisors, no canine, three bicuspids, three molars. The common mole has forty-four teeth, in the arrangement of which there is some difference among naturalists. M. Cuvier rates no canine to the lower jaw, and gives four bicuspids and three molars on either side to both jaws. Mr. Bell allows two canine to the lower jaw, gives no bicuspids, and makes seven molars to the upper, and six to the lower jaw, on either side; while M. Blainville has, to both upper and lower jaw, on each side, four incisors, one canine, three bicuspids, three molars.

In the hedge-hog, one variety has thirty-six teeth. The formula given is, incisors two, canine one, bicuspids three, molars three, to both upper and lower jaw, on either side. The common hedge-hog has the same number, but differently arranged as follows: incisors three, bicuspids four, molars three, on either side, in each jaw. Another variety has forty-eight, i. e. incisors three, canine one, bicuspids four, molars four, on either side, in each jaw.

CHEIROPTERA.—This order includes two divisions of the bats—first, those that live on insects, and second, those that live on fruits.

The number of teeth belonging to the first is thirty-eight, i. e. incisors two, canine one, bicuspids three, molars three, to the upper jaw, on either side; and to the lower, incisors three, canine one, bicuspids three, molars three.

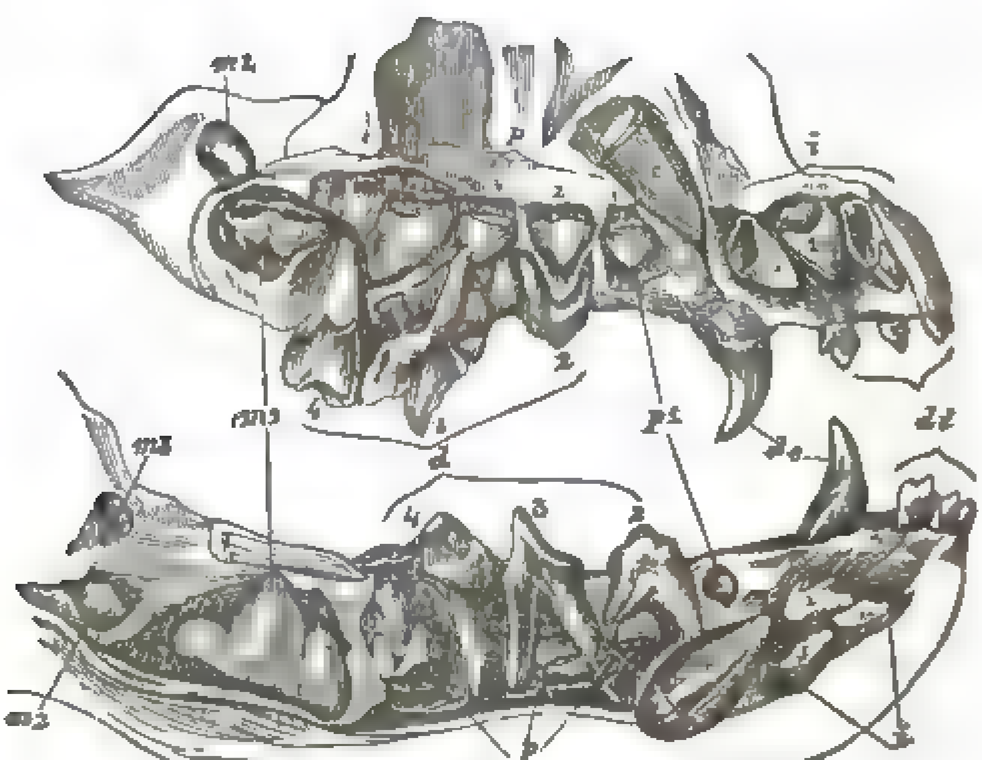
The vampire or blood-sucking bat has but twenty teeth.

The dental formula is, incisors one, canine one, bicuspids two, to the upper jaw, on either side; and to the lower, incisors two, canine one, bicuspids three. The bats which live on fruit have thirty-four teeth. Their dental formula is, to the upper jaw, on either side, incisors two, canine one, bicuspids two, molars three; in the lower, incisors two, canine one, bicuspids three, molars three.

CARNIVORA.—Animals of this order live entirely on one kind of food, i. e. flesh; and their dental system being designed not only to masticate, but also to obtain, seize, and kill their prey, their teeth are much more extensive than in man.

The different genera present variations from the regular type as established in the feline or cat tribe.

FIG. 76.



Among the whole order there are found to be six incisors in each jaw, with few exceptions. The canines are never absent, are largely developed, and have long, coni-

FIG. 76 represents the deciduous and permanent teeth of the dog. 2 3 4 d Deciduous molars of the upper and lower jaw. 2 3 4 p Permanent molars. d c Deciduous canine of both jaws. d i Deciduous incisors of both jaws. i Permanent incisors. 2 m 3 m Tubercular molars.

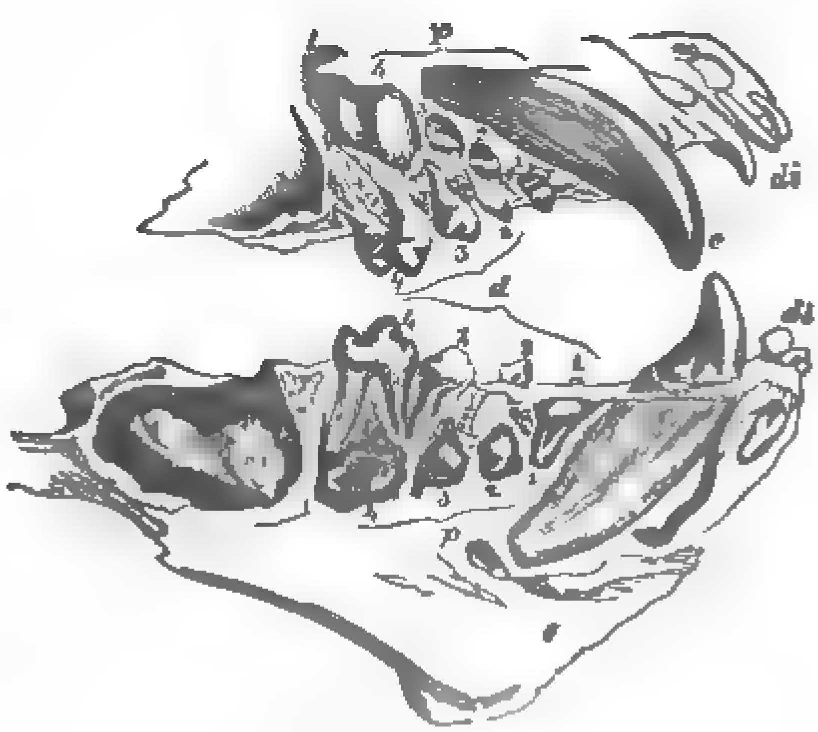
cal, sharp-pointed and cutting crowns. The variations from the type are found in the molars.

We will give a few examples in illustration. The *cat*, taken as the type of the order, has 28 teeth—the upper jaw having, on either side, incisors 3, canine 1, bicuspids 3, molar 1. In the lower jaw there are, incisors 3, canine 1, bicuspids 2, molar 1.

In the upper jaw the first bicuspid has a single root, with one exception. The second bicuspid has two strong diverging roots; the third has three. In the lower jaw the first bicuspid has two roots. The number of milk teeth in the cat is 26. The upper jaw has, incisors 3, canine 1, molars 3, on either side. In the lower jaw there are, incisors 3, canine 1, molars 2.

The *dog* has 42 teeth. (Fig. 76.) In the upper jaw there are on either side, incisors 3, canine 1, bicuspids 4, molars 2. In the lower jaw there is an additional molar.

FIG. 77.



There is a single root to the incisors, canines, and first bicuspids of both jaws, all the rest in the lower jaw have two, except the second bicuspid, which is connate. The second upper bicuspid, which is also called sectorial, has three roots, the first true molar has four, the last three roots.

FIG. 77 represents the deciduous and permanent teeth of the bear. 1 2 3 4 *d* Deciduous molars of the upper and lower jaw. *p* Permanent molars. *d i* Deciduous incisors. *c* Canine teeth.

The *hyena* has 34 teeth. In the upper jaw on either side there are, incisors 3, canine 1, bicuspids 4, molar 1. In the lower jaw there is one bicuspid less. The number of deciduous teeth is 28, i. e. incisors 3, canine 1, molars 3, to each jaw on either side.

The *weasel* has 34, the *otter* 36, the *badger* 30, the *raccoon* 40, the *bear* 42. (Fig. 77.) The deciduous teeth of the bear are 22, and the seal has 34 teeth.

MARSUPIALIA.—This order, so called from having a pouch for the accommodation of their young, are divided into the carnivorous and herbivorous genera.

The *opossum* and *kangaroo* are familiar examples under this head. The *dog-headed opossum* (thylacinus) has forty-six teeth. In the upper jaw, on either side, there are—incisors four, canine one, bicuspids three, molars four; in the lower jaw are found—incisors three, canine one, bicuspids three, molars four. In other varieties of the opossum the teeth vary in number, being 42, 48, 50 and 54. The *kangaroo* has twenty-eight teeth. The canines are absent. The animals of this genus live on herbs.

The dental formula is, to the upper jaw, on either side, incisors three, bicuspids one, molars four; in the lower jaw, there are, molars four, incisor one, bicuspid one. Other varieties have only twenty-four teeth.

RODENTIA.—This order includes the squirrel, rabbit, rat, beaver, &c.

The *incisors* form the distinguishing characteristic of this order. There is one on either side, separated from the short series of molars by a wide space. The upper ones describe a large segment of a small circle, and are regularly curved; the lower ones are a smaller segment of a larger circle.

These teeth are called "*scalpriform*" or chisel-like. The molar teeth are described as presenting numerous varieties, representing, in fact, all the modifications found in the omnivorous and herbivorous genera of mammalia. In some of the rodents, as the Chili rats, the molar teeth have no roots. In others, as the beaver, they have short roots.

The mode in which the teeth are implanted in the jaws varies according to the diet. Those, for example, like the true rat, which live on a mixed food, do not require so great a depth of the crown, and the teeth are hence not so firmly fixed, nor so large as in those rodents whose food is entirely vegetable, and where the friction is greater.

The highest number of teeth in this order is stated at twenty-eight. The rabbit has six molars on each side, in the upper jaw, and five in the lower. The squirrel has five molars in the upper on either side, and four in the lower. The rat has three molars on each side, in both jaws, though the spring-rat, as it is called, has four molars in both jaws, on each side.

EDENTATA.—It would be supposed from the name of this order that all the genera composing it were without teeth. Hence Mr. Owen very justly remarks, it is to be regretted that such a term should have been applied, seeing that all the species of this order, except two, have teeth, though nearly all are without incisors.

The *ant-eater*, *armadillo*, and *sloth*, are examples under this head.

The ant-eater has twenty-six teeth—seven on each side of the upper jaw, and six on each side of the lower. The number in the armadillo is stated to vary from twenty-four to twenty-six on each side of the upper jaw, and twenty-two to twenty-four in the lower; making, in the whole, from ninety-four to one hundred teeth. The *sloth* has eighteen teeth, all molars—there being five on each side of the upper jaw, and four on each side of the lower.

The extinct gigantic animals by the name of *megatheroids*, some of whose teeth are nearly a foot in length, belong also to this order.

PACHYDERMATA.—This order includes the elephant, mastodon, hippopotamus, rhinoceros, hog, horse, &c.

The *elephant*, distinguished by its two enormous tusks, has 28 teeth. In the upper jaw, on each side, there are two incisors and six molars. In the lower there are only six molars on either side. The tusks are situated in the inter-

maxillary bones, and are preceded by deciduous ones. These latter appear between the 5th and 27th month; are about two inches in length, one third of an inch in diameter, and are shed between the first and second year. In about a month or two after this period, the permanent tusks are described as cutting the gum, and are then about an inch in length.

At birth the alveolus of the permanent tusk is a round cell placed at the posterior and inner part of the temporary alveolus. The tusks are called the incisor teeth of the elephant, and are considered, in proportion to the body, the largest of all the teeth. They are stated to have measured nine feet in length, having a base of eight inches, and weighing 150 pounds. This is an unusual weight, the more common being from fifty to seventy pounds.

In some varieties the tusks are straight, and point downwards, and in others of a still more anomalous kind, one tusk has been seen horizontal, and the other vertical. The molar teeth are of immense size and complex structure. The crown is mostly hid in the socket, only a small portion appearing above the gum. It is divided into several perpendicular transverse plates—coated with enamel, and then covered with cement—which unites the several divisions of the crown; these divisions come together at the base and form the body of the crown from whence the roots proceed.

In the development of the grinders, the summits of the anterior plates begin to be formed first, and then the others in succession, the anterior being in use before the posterior are formed. The first molar is stated to have four of these vertical plates or divisions of the crown, and two roots. The second molar has eight or nine plates, and also two roots. The third molar has from eleven to thirteen plates, and has a small anterior and large posterior root. It is thought these three may probably be deciduous teeth.

The fourth molar has from fifteen to sixteen plates in the crown and three roots. The fifth molar has from seventeen to twenty plates, appears above the gum about the twentieth

year, and is found not to be shed before the sixtieth. The sixth and last molar has from twenty-two to twenty-seven plates. Its antero-posterior length in the line of the curvature is found to measure from twelve to fifteen inches, and breadth about three and a half inches.

The *mastodon* is an extinct race. It has the tusks of the elephant, and differs in its grinders, having their surfaces divided into "wedge-shaped transverse ridges," instead of the numerous vertical plates of the elephant.

The dental formula is given as twenty-eight; seven teeth on each side to the upper jaw, and the same number to the lower. This number, however, combines both the deciduous and permanent set.

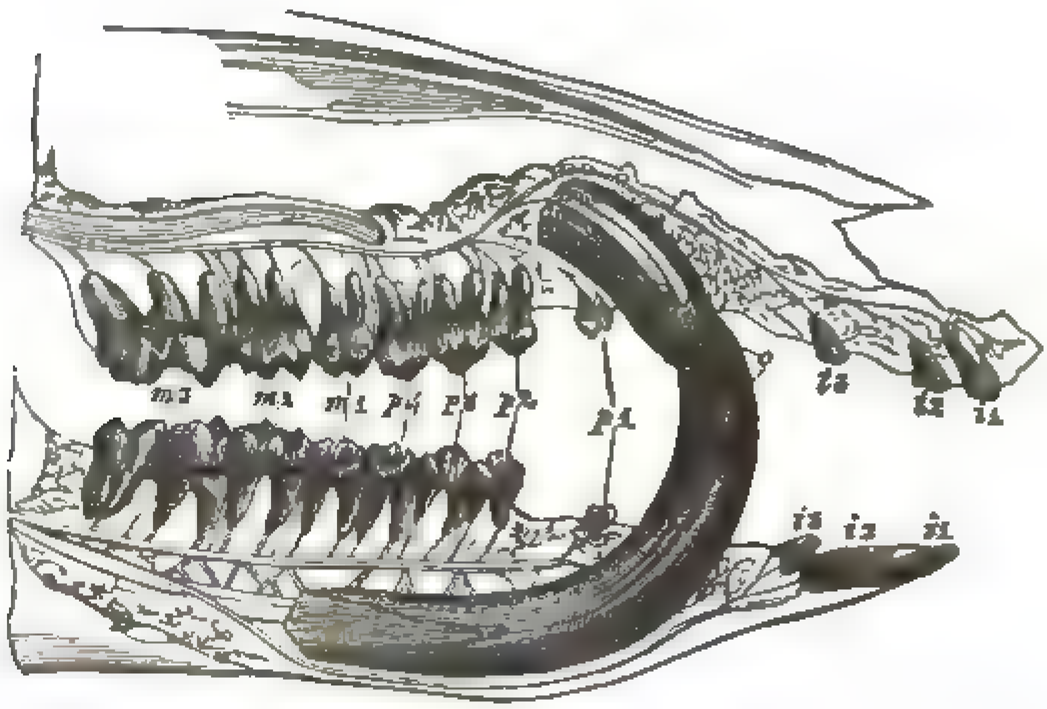
The *hippopotamus*. This monster of the waters is exceedingly interesting to the dentist, as from its teeth, in former times, were mostly supplied the best artificial substitutes for the human. It was most appropriate for this purpose, as the dentine was extremely hard, and sections of it susceptible of very high polish. The number of teeth, as given by M. Cuvier, is thirty-two, i. e. six molars on each side of each jaw, two incisors on each side of each jaw, and two canines also on each side of each jaw. The three anterior molars (the premolars of Mr. Owen) are conical; the posterior present two pairs of points. The upper incisors are short, conical and recurved, the inferior "prolonged, cylindrical, pointed, and horizontally projecting." The upper canine is straight, the lower very large and bent back, recurved.

Rhinoceros. This genus has no canine teeth. Its incisors vary, though the usual number given is eight, two on each side of both upper and lower jaw. The number of molars is twenty-eight. This animal is remarkable for its single horn, though in some varieties there are two. The African rhinoceros is said to have two horns, and no incisors.

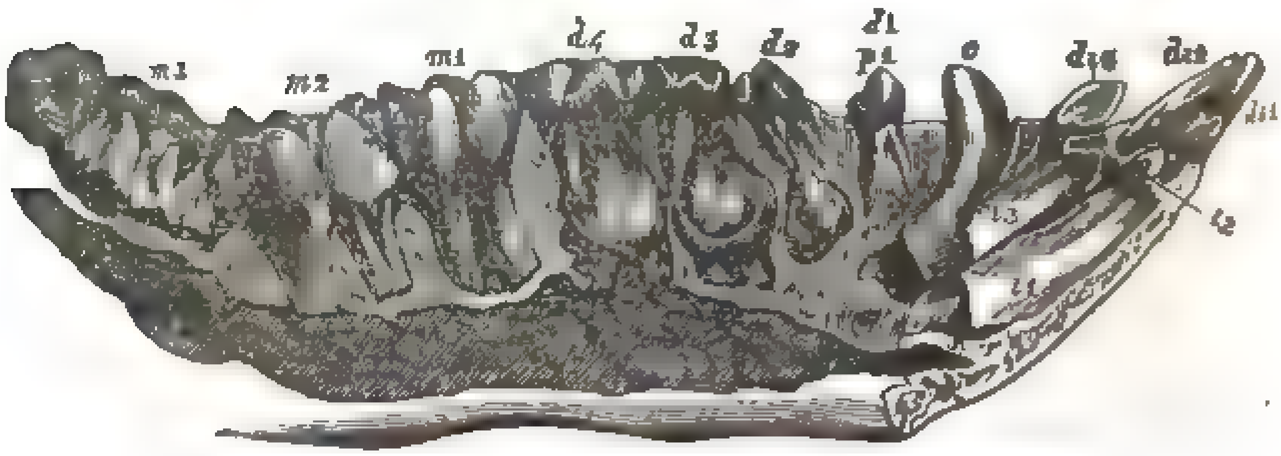
The *hog*, (*suidæ.*) This family, among the ungulata, comprises the greatest varieties in dentition. The canines form the most prominent feature of this group,

being remarkable for their "extraordinary size, shape, and direction." This is best illustrated in the wild boar, where

FIG. 78. A



B



they curve forwards, outwards and upwards. The molars are regarded as complex in structure as those of the elephant, while the incisors vary in number in the several genera. The usual number of teeth is set down at forty-four. To both jaws on either side there are, incisors 3,

FIG. 78, A represents the Permanent Teeth of the Hog. 1*m*, 2*m*, 3*m*, 1st, 2d and 3d Molars. 1*p*, 2*p*, 3*p*, 4*p*, 1st, 2d, 3d and 4th Premolars. 1*i*, 2*i*, 3*i*, 1st, 2d and 3d, Incisors. *c* Canine teeth.

FIG. 78, *B* represents the Deciduous and Permanent Teeth of the Hog. The figures and letters point so distinctly to the different kinds of teeth, as to require no further explanation.

canine 1, bicuspids 4, molars 3. The number of milk teeth is made twenty-eight. Incisors 3, canine 1, molars 3, to both jaws on either side.

In the *Peccari* the dental formula numbers thirty-eight teeth—i. e. in the upper jaw, on each side, there are, incisors two, canine one, bicuspids three, molars three; in the lower, on each side, are, incisors three, canine one, bicuspids three, molars three.

The Horse, (equidæ.) This noble and useful animal, belonging to the family *solidungula*, or single-hoofed variety, has forty teeth. In both jaws, on each side, there are three incisors, one canine, three bicuspids, and three molars.

FIG. 79.

The lower canines, according to M. Cuvier, are only sometimes present in the male, and always wanting in the female. Between the canines and first bicuspids there is a wide space corresponding to the angle of the mouth, where the bit is received. The incisors are slightly curved, having long, subtrahedral fangs, tapering to their extremity, and closely arranged in the segment of a circle. These teeth, says Mr. Owen, are distinguished from those of all other animals "by the fold of enamel which penetrates the body of the crown from its broad, flat summit, like the inverted finger of a glove." This fold encloses a cavity, which presents the form of an island, when the tooth begins to be worn. This cavity is partly filled by "cement, and partly by the discolored substances of the food, and is called the *mark*." It is described as being usually obliterated, in the middle incisors, about the sixth year—in the second incisors, about the seventh; and the third, about the eighth,

FIG. 79, A longitudinal section of the Incisor of a Horse. *e* Enamel. *d* Dentine. *c* Cement. *c'* Cement reflected into the depression of the crown. *s* Colored tartar and food filling up this cavity and constituting what is known as the "mark" and made use of to tell the age of the horse.

in the lower jaw. It is longer disappearing in those of the upper jaw.

RUMINANTIA.—This order is considered to be the best determined in the whole class of mammalia.

The camel, lama, dromedary, ox, sheep, goat, stag, &c., are varieties of this order.

The genera are divided into those which are without horns, and those which have them. The latter class is by far the most numerous. The camel and lama are examples of the former, while the ox, ram, stag, &c., are specimens of the latter. Another division is into those in which the horns are solid, and those in which they are hollow.

In the development of the horns and teeth, the relation seems to be inverse, for where the horns are present, we find the canines absent, and where the horns are wanting, as in the musk, canines are not only seen, but also a pair of incisors in the upper jaw.

The different genera are called *ruminantia*, from the peculiar faculty they possess of masticating their food a second time, by returning it to the mouth after first swallowing it.

This singular faculty depends on the structure of the stomach, or rather stomachs, which are four in number; and the first three are so related to each other that the food may enter either of them, as the œsophagus ends at their common point of communication.

The first stomach is called the *paunch*, and receives the vegetable matters from the first mastication. This passes into the second, which is of *honey-comb* formation, and here the food is moistened and compressed into little pellets called *cud*, which is now returned into the mouth to undergo a second mastication. It is now passed from the mouth into the third stomach, which is laminated in its appearance, and from this it enters into the fourth, which has the *rugæ*, and which is the seat of digestion proper.

One characteristic in the teeth of this order is, the absence of incisors and canines in the upper jaw. This is furnished by a callous pad as a substitute. A second char-

acter is the constancy of eight incisors in the lower jaw, the two outer of which Mr. Owen calls canine. The usual dental formula gives 32 teeth to the ruminantia: 6 bicuspids and 6 molars to the upper jaw; to the lower, 6 incisors, 2 canines, 6 bicuspids, and 6 molars. A wide space separates the incisors and bicuspids.

The upper bicuspids have three roots; the upper true molars have four roots. In the lower jaw both bicuspids and molars have but two roots; but the second root in the last molar consists of two connate roots.

CETACEA.—This order of mammalia includes the whales, which have no teeth,* properly speaking, but horny substitutes, called "*whale-bone*" or "baleen." The so-called teeth of the right whale are in the form of plates, terminating in a fringe of bristles. In a new-born whale Mr. Owen found the number of these plates to be 190. The largest are arranged on each side of the upper jaw in a longitudinal series and close to each other, vertically, with their flat surfaces looking forwards and backwards, and their free margins outwards and inwards. The smaller plates are disposed in an oblique series within the larger. The base of each plate is described as being fixed upon a pulp developed within a broad, shallow depression of the gum, and covering the entire surface of the maxillary and anterior portion of the palate bones—the whale thus having palatal teeth. The base of each plate is hollow, for receiving the pulp—bearing the same relation to it that the pulp of a true tooth does to its cavity.

THE SECOND CLASS OF ANIMALS, BIRDS (AVES.)

As the organs of prehension of this class consist of a horny substance, and are therefore not teeth properly speaking, a remark or two is all that is considered necessary to be made in reference to these substitutes or mere representatives of teeth.

It is true, as has been remarked, that strictly speaking,

* Some varieties in this order, it is thought, have teeth proper.

the beak of the *bird* is an organ of prehension and mastication, and often a powerful weapon for either offence or defence, though in its form and structure it is more like the claws and nails than teeth.

The beak in birds of prey is hard, in water birds it is comparatively soft. The *form* is very various, and corresponds with the kind of food and the habits of the several varieties. In some birds of prey it is curved into a "hook with sharp cutting edges." In others, as in the stork, it is straight; some have it bent downwards, others upwards; some have it compressed, as the penguin, transversely; and others, as the duck, have it flat.

The jaws present, in some, distinct elevations or notches, resembling teeth. The duck has these indentations regularly arranged, and supplied with branches of the inferior maxillary nerve.

THIRD CLASS OF ANIMALS—REPTILES (REPTILIA.)

The teeth of this class, occupying a position intermediate between those of the bird and of the fish, are thought to partake thereby of the characteristics of both.

The tortoise has the beak of the bird, and with this exception all other reptiles are said to have true teeth. These are pointed and conical, and resemble more those of the carnivorous class, and form weapons of attack and defence.

The number of teeth belonging to reptiles is not determined, but it is greater than in man. They are fixed in the jaws, though sometimes as in the serpent, are placed in the palate. They are without roots, and are fixed in alveoli which are more narrow at their external opening than at the bottom.

The teeth of this class are developed at a very early age, and always the number is the same. Those which have just come forth from the egg have as many as the adult animal, ten or twenty feet in length.

Reptiles shed their teeth, it seems, with greater frequency and facility than most other animals. These or-

gans grow with age, and are found of a size proportionate to the dimensions of the animal.

Serpents have teeth both upon the palate and jaws. The venomous teeth are attached to the upper maxillary bone, and are curved backward in a semi-circular form. The roots are situated in the anterior part of the jaw, and are not movable, according to Mr. Blandin, but are fixed firmly to the bone; the jaw itself, which is movable, causing the apparent motion. These poisonous teeth are much longer than any other—and have a canal running the whole length of the teeth, which contains the excretory duct of the gland furnishing the poison. This canal terminates on the free extremity of the tooth by an opening, through which the animal ejects the poison. The sac surrounding the base of the fang has within it several rudi-

FIG. 80. B

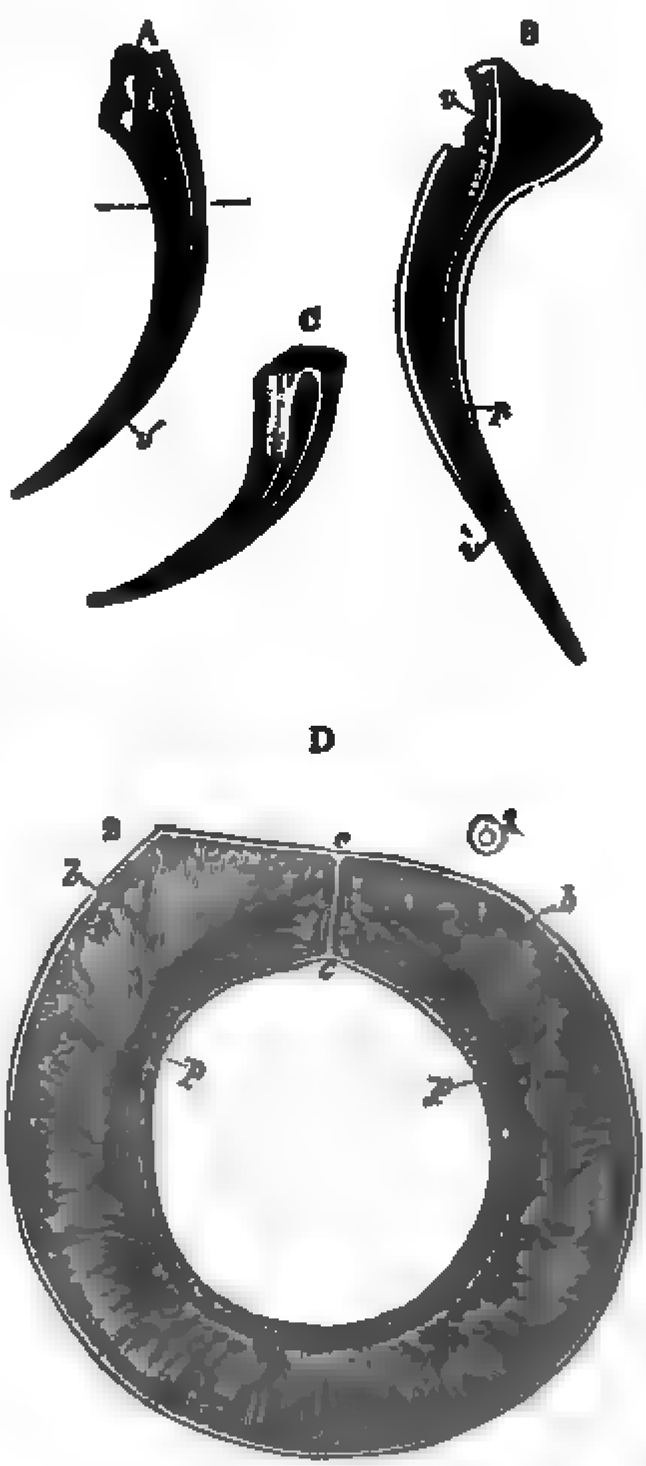


FIG. 80, A, B, C represent the poison Fangs of Serpents. B Longitudinal section of the fang. *v* poison duct; *accented v* its outlet.

FIG. 80, D represents also a section of the poison fang magnified—*p p* showing pulp canal, calcigerous tubes, and dentine enclosing the poison canal.

mentary fangs. As many as eleven have been seen, so that when one is shed there is another to take its place.

All the frogs are said to have teeth in both jaws, and all, with the exception of a single variety called the *pipa*, have teeth in the roof of the palate.

FOURTH CLASS—FISHES, (PISCES.)

Fish constitute the last class of the vertebrated division of the animal kingdom. Their dental system presents great variety, both in number and arrangement. The teeth are found in all parts of the mouth and pharynx, and are distinguished, according to their situation, into *intermaxillary, mandibular, palatine, vomerial, lingual, bronchial,* and *pharyngeal.*

The teeth of fish are either received into alveolar cavities, and are firm and immovable, or are removed from the maxillary bones, and have not the cavities, as in the cartilaginous fishes, except the saw fish, and are movable as in the shark, which has the power of elevating and depressing its teeth.

Fig. 81.

The fact of the teeth being thus removed from the bone and connected with mucous membrane, is regarded as conclusive in reference to the theory of their origin from mucous membrane.

The form of the teeth of fish is exceedingly various—some are conical, others flattened; the conical form the largest number, and sometimes present a single point, at others two or three points. In a variety called the *scarius* there are five or six rows, composed each of five or six teeth united by a species of cement.

Fig. 81 represents the teeth of the Rock Fish, (labrus.) They are attached to the inferior pharyngeal bone, are very numerous, are scattered over a broad surface, and are said to resemble a "pavement."

The osseous teeth, fixed in alveoli, are, after their full development, described as being "closely soldered to the circumference of the cavity in which they are placed."

Those fish whose teeth are sharp, with a strong inclination backwards as in the pike, or tooth-like and cutting as in the shark, are regarded as the most carnivorous and voracious. Those on the other hand whose teeth are flattened, or only pharyngeal, are viewed as the least carnivorous and most peaceable in their dispositions.

SECOND DIVISION OF THE ANIMAL KINGDOM.

THE INVERTEBRATA OR ANIMALS DESTITUTE OF A SPINE.—The teeth of this division have an analogy of function with those of the vertebrata, being situated, many of them, at or near the mouth of the alimentary tube, and laying hold of, retaining, and dividing the food—thus performing the functions of prehension and mastication, though in structure they are considered by some as farther removed from true teeth than the hair.

The teeth of the invertebrated division are mostly found in the stomach—a very singular and striking fact; and Mr. Blandin remarks, "The higher the animal is elevated in the scale, the higher are the dental organs elevated in the alimentary canal.

"In the crustacea and mollusca they are placed principally in the stomach. In fishes they reach the pharynx. In reptiles the posterior part of the mouth—whilst in the mammalia they are confined to the anterior and lateral parts of the mouth."

In the crustacea the dental organs found in the stomach consist of calcareous matter placed on a kind of skeleton. This so-called skeleton of the stomach is composed of transverse and lateral ribs, to which these teeth are attached. Upon the lateral ridges the two larger teeth are placed and have flat crowns, with depressions. The crown in the crab is striated, and has on its inferior border large "denticulations."

The great lobster is described as having nine of the rib-

like elevations. At the point of junction of the lateral and transverse ridges, another ridge is spoken of as branching off, which has a tooth, and also three and sometimes five sharp, hooked, and small pointed elevations.

The hooked teeth are represented as seizing the food and carrying it between the teeth with flattened crowns.

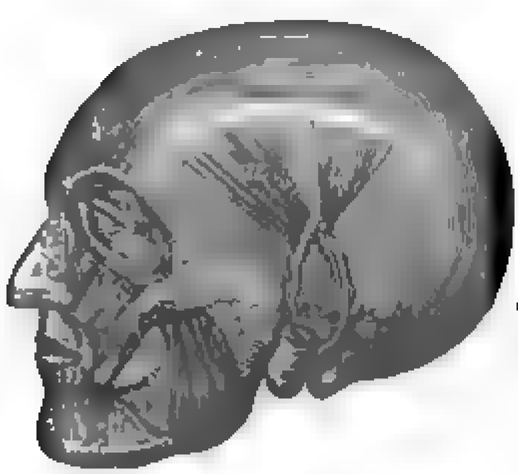
Insects and worms cannot be said to have any organs which can be compared to teeth. The stomachs of some of them seem to be furnished with "scales or horny hooks," which are supposed to be intended for a kind of mastication.

SECTION VI.

ACTIVE ORGANS OF MASTICATION, CONSISTING OF MUSCLES.

1. *Masseter Muscle.*—The same dissection made for the muscles of prehension will exhibit this muscle.

FIG. 82.



The *masseter* (μασσαομαι, I chew) is a superficial, thick, and strong muscle, situated at the side and back part of the face, and extended between the zygoma and angle of the lower jaw. It consists of two portions, an anterior and posterior, or superficial and deep, which decussate. The *anterior* is the larger, and *arises* tendinous from the inferior edge of the malar bone, and from the point where it unites with the maxillary. The posterior *arises* fleshy from the zygomatic arch as far back as the glenoid cavity. The fibres of the anterior portion pass backwards and downwards; of those of the posterior, some descend obliquely

FIG. 82 Lateral view of the Muscles of the face, cranium, and external ear. 1 Occipito-frontalis, 2 Orbicularis palpebrarum, 3 Pyramidalis nasi, 4 Compressor nasi, 5 6 Levator labii superioris alæque nasi, 7 Zygomaticus minor, 8 Zygomaticus major, 9 Masseter muscle, 10 Buccinator, 11 Depressor anguli, or triangularis oris, 12 Depressor labii inferioris, 13 Orbicularis oris, 14 Anterior auris, 15 Superior auris, 16 Posterior auris, 17 External lateral ligament, 18 Deep-seated portion of masseter, 19 Fascia temporalis.

forwards, others vertically, and both portions are *inserted*, tendinous and fleshy, into the external surface of the angle and ramus of the lower jaw as high as the coronoid process.

Function. If the anterior portions of both muscles act together, the jaw is carried forwards—if the posterior act, it is carried backwards; if both anterior and posterior, on opposite sides, act together, the lower jaw will be powerfully raised to the upper. If the superficial portion, on the one side, act alone, it can throw the chin to the opposite side. If the deep portion act by itself, it can rotate the jaw to its own side.

This muscle is one of the chief agents in mastication, as it has the power of directly bringing the lower jaw to the upper, and thereby dividing the food, and also of rotating it, whereby its trituration is effected.

The masseter is covered by the skin, a few fibres of the platysma, orbicularis palpebrarum, and zygomatic muscles, as well as by a part of the parotid gland and duct, and the transverse facial vessels and nerves.

2. *Temporalis Muscle*—(*tempora*, the temples.)

Dissection.—Make an incision along the semicircular ridge upon the side of the cranium, extending from the external angular process of the frontal bone, along the parietal, back to the mastoid process of the temporal bone. Turn this portion of skin down to the zygoma, and the *temporal aponeurosis* is brought to view. This is a white, strong, and shining fascia, which is attached above to the semicircular ridge, and below to the zygoma. It covers the temporal muscle—is thin above where the muscle is seen through it, and thick below where

FIG. 83.

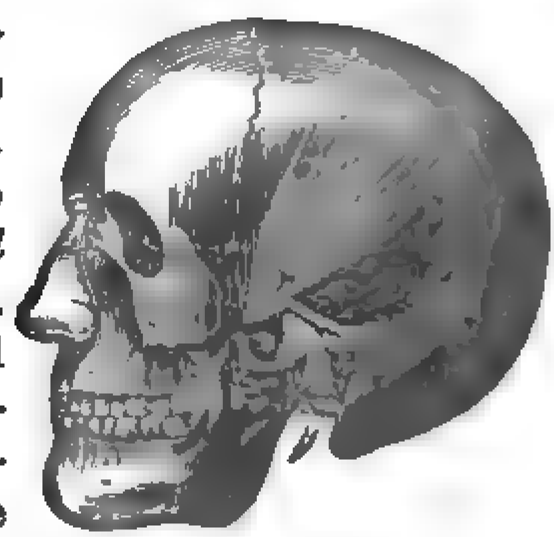


FIG. 83 Temporal Muscle, the fascia being removed. 1 Temporal muscle, 2 External lateral ligament, 3 Insertion of temporal muscle.

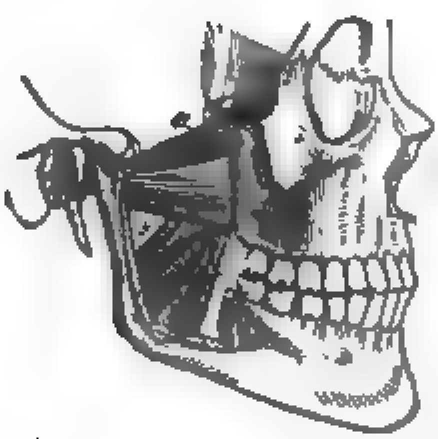
it consists of two layers separated by some fat, vessels, and nerves. Turn this fascia down to the zygoma, and the upper and larger portion of the temporal muscle is exposed. Now saw through the zygomatic arch at either end, and turn it down with the masseter, and we have brought to view the lower portion of the temporal. Thus exposed, the temporal muscle is seen to *arise* on the side of the cranium from the whole length of the semicircular ridge, and from the surface below this ridge, formed by the frontal, parietal, squamous portion of the temporal, and greater wing of the sphenoid bone, as low down as its crest; and from the under surface of the fascia temporalis. From this extensive origin, the fibres converge to a strong tendon, which is *inserted* into the coronoid process, nearly surrounding it, and continues forwards as far as the last molares.

Function.—To bring the lower jaw to the upper, in the cutting of the food in mastication. The posterior fibres, by drawing the lower jaw backwards, are a great security against dislocations of this bone.

3. *Pterygoideus externus.*

Dissection.—Turn off the masseter muscle close to the bone, and take out a section of the ramus by sawing between its angle, and the root of the condyle, and the pterygoid muscles will be exposed.

FIG. 84.



The *pterygoideus externus* is a short triangular muscle, running horizontally and situated deep behind the ramus of the lower jaw. It *arises* by two heads—the one from the crest on the great wing of the sphenoid bone, at its root, the other from the outer surface of the external pterygoid plate, and tuberosity of the upper maxilla—the two portions converge and pass

FIG. 84 represents the Pterygoid Muscles; the zygomatic arch and ramus of the lower jaw being removed. *a b* Pterygoideus externus. *c* Pterygoideus internus.

backwards and outwards, to be *inserted* into the internal and anterior part of the neck of the lower jaw and the interarticular cartilage.

Function.—When one muscle acts, it turns the jaw to the opposite side; when both act alternately, they give the rotatory or grinding motion. If they act together, the jaw is thrown forward.

4. *Pterygoideus internus*, (*Fig.* 84.)

This muscle is thick and short, and situated behind the ramus and angle of the inferior maxilla. It is inferior to the external pterygoid, and parallel to the superficial layer of the masseter.

It *arises* fleshy and tendinous from the inner surface of the external pterygoid plate, and pterygoid process of the palate bone, occupies the greater portion of the pterygoid fossa, and passes downwards and outwards to be *inserted* tendinous and fleshy on the inner surface of the angle of the jaw.

Function.—It is a rotator of the jaws and thus co-operates with the external pterygoid in triturating the food.

The two pterygoid muscles arising so near each other and passing in different directions, the one downwards, and the other upwards and outwards, a triangular space is left between them, containing a quantity of fat, the internal maxillary artery and vein, the inferior dental and gustatory nerves, and a portion of the parotid gland. The internal maxillary artery occasionally passes between the origins of the external pterygoid muscles, as it is about entering the spheno-maxillary fossa.

COMBINED ACTION OF THE MUSCLES OF MASTICATION.

The conjoint action of these muscles is the effective agent in mastication. The masseter and temporal are principally employed in raising the lower jaw to the upper, and thus dividing the food, while the pterygoid in rotating the lower jaw upon the upper, produces the grinding motion, and thus reduces the food to the smallest portions, suitable for deglutition. The anterior layer of the

masseter and the posterior fibres of the temporal can also assist the pterygoid in the grinding process, while the buccinator comes in to their aid by keeping the food under the teeth. So that the whole are so adapted to each other as to act in the utmost harmony for the most perfect performance of the function of mastication.

Blood-vessels, (Fig. 73.)—The arteries supplying the muscles of mastication come from the temporal, the external and internal maxillary arteries, and are named according to the muscles they supply, as the temporal, masseteric, and pterygoid branches. The veins correspond to the arteries and return the blood into the external jugular.

Nerves, (Fig. 74.)—The nerves supplying the muscles of mastication come from the *fifth* and *seventh* pair. The motor division of the inferior maxillary branch of the fifth, seen in the zygomatic fossa, sends off five muscular branches, i. e. the two *deep temporal*, *masseteric*, *buccal* and *pterygoid*, going to the muscles of the same name.* The *portio dura* or *facial nerve* is a branch of the seventh, which also supplies the muscles of mastication. It is situated in the substance of the parotid gland, anastomoses freely with the fifth, and is described more minutely under the head of organs of expression, which see.

SECTION VII.

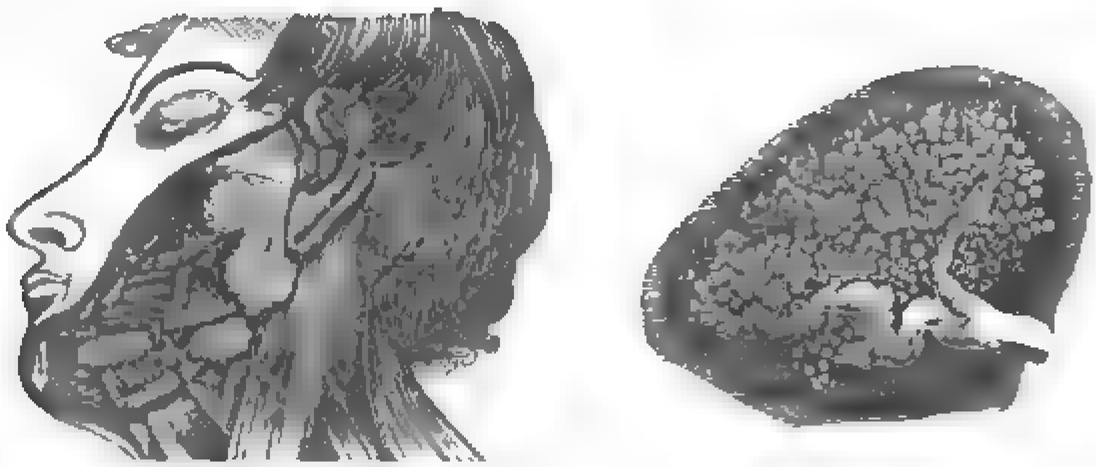
ORGANS OF INSALIVATION, COMPRISING THE SALIVARY GLANDS.

The salivary glands are six in number—three on each side of the face, i. e. the *parotid*, *submaxillary*, and *sublingual*. These glands belong to the conglomerate order, that is, they consist of numerous little follicles, (Fig. 85, B,) averaging about the one-twelve-thousandth of an inch in diameter, surrounded by a plexus of capillary blood-vessels, and presenting the appearance of a multitude of small granules—each being a gland in miniature, and each, consequently, having its own artery, vein, and excretory duct. It is by the combination of these various little excre-

* See inferior maxillary nerve, under the head of nerves supplying the teeth, for a more minute account.

tory ducts that one common duct is formed, whose office is to carry the saliva, furnished by these glands, into the mouth.

A FIG. 85. B



These salivary glands are developed from the mucous membrane of the mouth, which being reflected in the form of a tube, sends off bud-like processes whose ultimate terminations constitute the follicles just described.

1. *The Parotid.*

Dissection.—This gland, so called from its situation about the ear, (παρα, near, ους ωτος, the ear,) is brought to view by the same dissection, for exposing the organs of prehension. It is covered by a dense fascia, the *fascia superficialis*, continued from the neck, which sends down into its substance numerous processes which serve to separate its granules, and conduct to it its blood-vessels. This fascia must be separated from its strong attachment to the cartilaginous portion of the meatus externus, and removed, when the parotid will be fairly exposed. It presents a pale, rough, granulated surface, and is the largest of the salivary glands. It has no regular figure, but occupies the space reaching from the zygoma above, to the angle of the jaw below; and from the mastoid process and sterno-cleido mastoid muscle behind, to a short distance over the masseter muscle in front—while in depth, it passes behind the

FIG. 85, A represents the Salivary Glands. 1 Parotid gland, 2 Duct of Steno, 3 Submaxillary gland, 4 Duct of Wharton or submaxillary duct, 5 Sublingual gland.

FIG. 85, B represents a lobule of the parotid gland of a new-born infant injected with mercury—magnified fifty diameters.

ramus of the jaw, extends back to the styloid process, which, with its muscles, it envelops—is in contact with the internal carotid artery, jugular vein, and eighth pair, or par-vagum nerves, and finally fills the posterior part of the glenoid cavity of the temporal bone.

Each of the granules composing this gland has, as already stated, an excretory duct, which, uniting with its fellows, forms one common duct called the parotid duct, or the duct of Steno, which is seen issuing from the gland at its anterior and posterior part, and is then traced passing over the masseter, about an inch below the zygoma, and through a quantity of soft lobulated fat, on the anterior edge of this muscle. It then pierces the buccinator at its upper part, opening into the mouth by a papilla (sometimes there is none) opposite the second or third molar tooth of the upper jaw.

A line drawn from the lobe of the ear to a point midway the root of the nose and lower margin of the upper lip, will give the direction of the parotid duct. This duct has two coats—an outer of condensed cellular, and an inner of mucous membrane. Between the zygoma and this duct, a small glandular mass is occasionally seen, having a small duct which either unites with the duct of Steno, or enters separately into the mouth. It is called the *socia parotidis.*

Function.—The use of this gland is to secrete the larger portion of the saliva with which the mouth is supplied, and which is carried thither by the duct of Steno.

2. *The Submaxillary Gland*—(Fig. 85.)

Dissection.—Make an incision along the base of the lower jaw, from the chin back to the angle, and along the ramus, the same as for the organs of prehension. Make a second incision along the median line at the upper part of the neck as far as the hyoid bone, commencing at the lower portion of the symphysis menti, and turn down the skin obliquely towards the clavicle. This exposes the broad muscle of the neck, the *platysma myoides*, and the superficial cervical fascia. Turn these down, and the submaxillary gland is exposed. This gland is second in size to the

parotid—is covered by cellular structure, and surrounded by lymphatic glands. It is of an oval shape, and pale color, and occupies a triangular space at the upper part of the neck, bounded anteriorly by the base of the lower jaw—posteriorly and internally by the tendon and anterior belly of the digastric muscle—externally by the stylo maxillary ligament, and the pterygoideus internus muscle.

The structure of the submaxillary is the same as the parotid, consisting of granules having each an excretory duct, which unite together into one common duct, called the *duct of Wharton.* This duct leaves the gland at its anterior or middle portion, and winds above the mylo-hyoid muscle, between it and the hyoglossus, thence passes forwards between the genio-hyo-glossus and sublingual gland, the latter of which it touches, and finally ends in a prominent papilla, by an open orifice, on either side of the frenum linguæ. This duct has thinner walls, but a larger calibre than that of the parotid. It is about two and a half inches long, and is accompanied by the gustatory nerve.

Function.—To secrete saliva, which is carried by the duct of Wharton into the mouth. If this duct, from any cause, be obstructed, the saliva accumulates on the under surface of the tongue, beneath its tip, forming a tumor called *ramula.*

3. *The Sublingual Gland*—(Fig. 85.)—This gland, oblong in shape, and of all the salivary glands, smallest in size, is seen by raising the tip of the tongue, and, as its name implies, is on the under surface of its anterior and lateral part. It is covered by the mucous membrane, and rests on the mylo hyoid muscle. It is related to the genio-hyo-glossus and duct of Wharton internally, and is connected behind with a process of the submaxillary gland. Its excretory ducts do not form a common duct, but have been seen to enter the mouth separately by fifteen or twenty small orifices, on a kind of fold or crest of the mucous membrane, between the tongue and inferior bicuspid and canine teeth. The ducts, some of them, enter the duct of Wharton.

Function.—The same as the parotid and submaxillary.

Blood-vessels.—The salivary glands are abundantly supplied with blood-vessels. The arteries going to the parotid come from the external carotid (Fig. 73) and its branches the facial, superficial temporal, transverse facial, and anterior and posterior auricular. The veins take the same direction as the arteries, have the same names, and terminate in the jugular. The submaxillary is supplied by the facial and lingual. The sublingual gland has its supply from the sublingual and the submental branches. The veins correspond to the arteries.

Nerves.—The parotid is supplied with nerves from the auricular branch of the inferior maxillary, (Fig. 74,) and auricular branch of the cervical plexus; the facial, and filaments of the sympathetic, from those of the external carotid artery. The submaxillary gland is supplied from the submaxillary ganglion, the lingual, and mylo-hyoid branch of the inferior dental nerve.

Saliva is a term indiscriminately applied to the secretions furnished by the salivary glands, and, until very recently, has been supposed to be of the same character, whatever its source. It was generally examined mixed with the other fluids of the mouth, so that its precise character could not be definitely fixed. It was regarded as alkaline, in a state of health, which more recent observations confirm; while the fluids of the buccal mucous membrane have been found to be acid.

The microscope reports the *saliva* to contain minute corpuscles, and large epithelial scales derived from the mucous membrane of the mouth. Its chemical constitution is furnished by the chemists Frerichs and Wright, two of the most recent authorities, and whose analysis is regarded as the most accurate. The former makes saliva to consist in a hundred parts: of water, 994.10; solid matters, 5.90; ptyaline, 1.41; mucus and epithelium, 2.13; fatty matter, .07; sulpho-cyanide of potassium, .10; alkaline and earthy chlorides and phosphates, 2.19.

Wright's analysis is in a hundred parts: water, 988.10; solid matters, 11.90; ptyaline, 1.80; mucus and epithelium,

2.60; fatty matter, .50; albumen with soda, 1.70; sulpho-cyanide of potassium, .90; alkaline and earthy salts, 3.20; loss, 1.20.

Ptyaline is the term applied to a substance upon which the peculiar properties of the saliva are made to depend, and is regarded as albuminous in its character. The ptyaline of Wright, however, differs from that of other observers.

Now the experiments of M. Bernard seem to show that saliva is not only not the same, but presents quite different properties and uses, as obtained from the parotid, submaxillary, and sublingual glands. That from the parotid is found to be thin, watery, abundant, (varying, however, according to the food,) readily penetrating substances, and believed to be especially designed to aid in mastication and assimilation, and is the fluid chiefly concerned in forming the food into a bolus, for its onward passage from the mouth into the pharynx.

The saliva from the sublingual is described as "viscous and adhesive, incapable of penetrating substances, but admirably adapted to cover their surface with a viscid coating, which much facilitates their being swallowed," and is the fluid especially concerned in deglutition. This gland is said to remain quiet during mastication, but to begin to act as soon as deglutition commences.

The submaxillary gland furnishes a saliva partaking of the characters of both the former, and supposed to be especially concerned with the sense of taste, diminishing the pungency of sapid bodies, and reducing their cohesion.

SECTION VIII.

ORGANS OF DEGLUTITION.

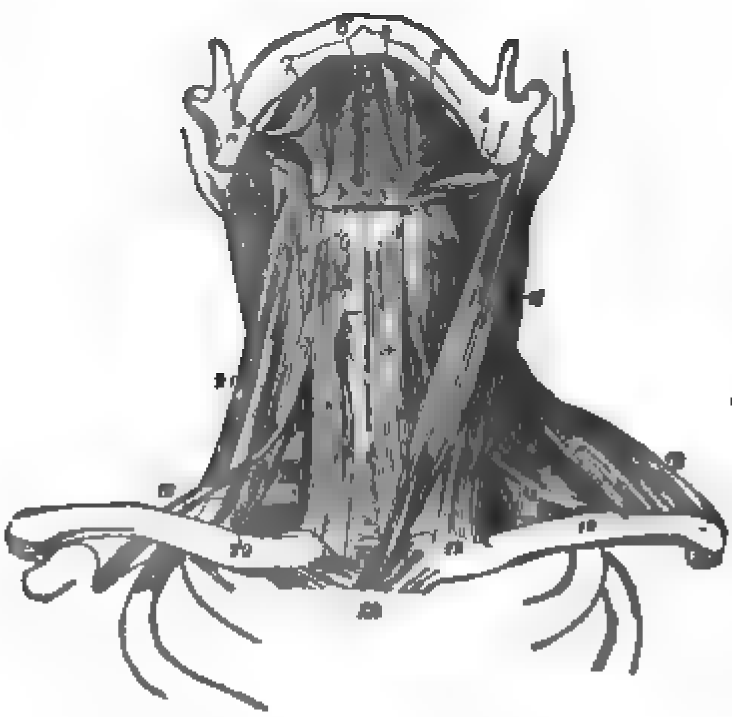
The organs of deglutition consist of the *muscles* forming the floor of the mouth, the *pharynx*, *soft-palate*, and *tongue*.

THE MUSCLES.

Dissection.—The same incisions are required as were resorted to in exposing the submaxillary gland.

Digastricus Muscle—(δις, twice, γαστηρ, belly.) This muscle is composed of two fleshy bellies, an anterior and posterior, with a round tendon in the centre. It is situated below the base of the lower jaw, at the anterior and lateral portions of the neck. It *arises* from the groove on the inner side of the mastoid process of the temporal bone, descends fleshy, obliquely forwards and inwards, till it approaches the os-hyoides, when it becomes tendinous, perforates the stylo-hyoid muscle, connects itself by a strong fascia—sometimes by a ring-like pully—to the hyoid bone, and then passes forward again fleshy, forming the anterior belly, to be *inserted* into a depression, close to the symphysis, on the inner side of the lower jaw.

FIG. 86.



Function.—To draw down the lower jaw, and to elevate the os-hyoides, tongue and larynx, when the mouth is closed. When the anterior belly acts it can draw these parts forwards. When the posterior acts they are drawn backwards. It exerts, by these varied actions, great influence over deglutition.

Mylo-hyoideus, (μυλη, a molar or grinder,) Fig. 86, is a broad, triangular muscle, forming the floor of the mouth,

FIG. 86 represents the muscles at the base of the lower jaw, and upper and front part of neck. 1 Posterior belly of the digastricus. 2 Its anterior belly 3 Ligamentous loop through which it plays. 4 Stylo-hyoideus. 5 Mylo-hyoideus. 6 Genio-hyoideus. 7 Tongue. 8 Hyo-glossus. 9 Stylo-glossus. 10 Stylo-Pharyngeus. 11 Sterno-cleido-mastoideus. 12 Its sternal origin. 13 Clavicular attachment. 14 Sterno-hyoideus. 15 Sterno-thyroideus. 16 Thyro-hyoideus. 17 Anterior belly of omo-hyoideus. 18 Posterior belly of omo-hyoideus. 19 Anterior edge of trapezius. 20 Scalenus anticus. 21 Scalenus posticus. 22 Scalenus medius.

and fully exposed on removing the anterior belly of the digastric. It *arises* from the myloid ridge on the inner side of the lower jaw, and descends inwards and backwards to be *inserted* into the base of the os-hyoides, and along with its fellow into the middle tendinous line, between that bone and the chin.

Function.—To bring the os-hyoides forward and project the tongue. This muscle is covered by the digastric muscle, the submaxillary gland, the platysma and fascia, and lies upon the genio-hyoid, hyo-glossus, and stylo-glossus muscles—the duct of Wharton, lingual and gustatory nerves, and sublingual gland.

Remove this muscle by dividing it on either side, and we see the next in order, i. e. *Genio-hyoideus*, (γενειον, the chin,) Fig. 87. It *arises* from the posterior mental tubercle above the digastric, by a small tendon, and descends backward to be *inserted* into the base of the os-hyoides. *Function.*—To bring the os-hyoides forward, and to protrude the tongue against the incisor teeth, or out of the mouth.

Genio-hyo-glossus, (γλωσσα, the tongue,) is seen by removing the genio-hyoideus. It is a triangular muscle, and *arises* by a small tendon from the posterior mental tubercle, above the genio-hyoideus and below the frenum linguæ, and is *inserted* into the tongue along the mesial line its whole length, and into the body of the os-hyoides. Its fibres radiate in different directions; some

FIG. 87.

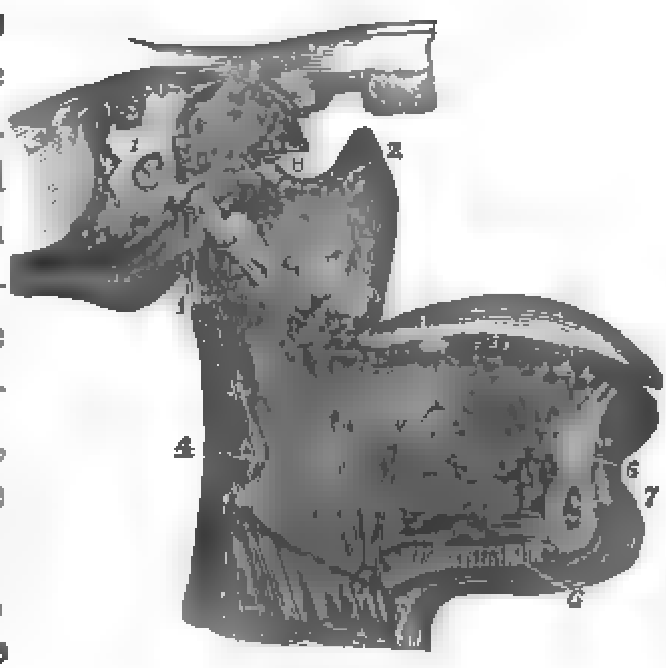


FIG. 87 represents a side view of the Tongue and its principal Muscles. 1 Mastoid process. 2 Coronoid process. 3 Stylo-glossus muscle. 4 Hyo-glossus. 5 Genio-hyo-glossus. 6 Genio-hyoideus. 7 Symphysis menti. 8 Styloid process.

pass forward to the tip of the tongue, others backward, while another set are in the middle.

Function.—The anterior fibres can depress the tip of the tongue, the posterior bring forward the os-hyoides and protrude the tongue, while the middle set can make it concave from side to side.

Hyo-glossus (Fig. 87) is a quadrilateral muscle, *arising* from the body and whole of the cornu of the os-hyoides, and *inserted* into the side of the tongue between the stylo-glossus and the lingualis. *Function.*—To depress the sides of the tongue, and thus render its dorsum convex.

Stylo-glossus (Fig. 87,) *arises* tendinous and slender from the styloid process near its apex or free extremity, and from the stylo-maxillary ligament, and is *inserted* in two portions, into the side of the tongue—one portion blending with the hyo-glossus, and the other being continued forward to the tip of the tongue.

Function.—To raise the tip of the tongue against the incisor teeth, and draw it backward, and to one side.

Stylo-hyoideus (Fig. 86) is a small, delicate muscle, *arising* near the base of the styloid process, on its outer side, passing obliquely forwards and inwards, parallel to the posterior belly of the digastric, whose tendon perforates it. It is *inserted* into the body of the os-hyoides. *Function.*—To draw back the os-hyoides and tongue, and thus assist the posterior belly of the digastric. A ligament, called stylo-hyoid, often accompanies this muscle, and is sometimes found ossified.

SOFT PALATE.

The *palate* has been divided into hard and soft. The hard is composed of the palatine plate of the palate bones. The soft palate is attached to the posterior margin of the hard, and consists of a dense aponeurosis, muscles and glands, enclosed in mucous membrane. The soft palate, (*velum pendulum palati,*) on depressing the lower jaw, is seen at the posterior part of the mouth, suspended transversely in the form of a membranous curtain.

This pendulous portion is the vertical or inferior part, while above, the soft palate is extended backward on a level with the hard, forming what is called its horizontal portion, and thus increasing the palatine arch.

The velum palati is a membranous valve separating the mouth from the pharynx and posterior nares, and, in fact, acts the part of a double valve. In deglutition, this velum is raised and applied to the posterior nares, to prevent the food from passing in this direction when entering the pharynx, and after the food has entered the pharynx it falls down into its original position, and prevents the return of the food into the cavity of the mouth. The velum presents a broad, quadrilateral shape, and has two surfaces—the one looking towards the tongue—the *lingual;* the other towards the nose—the *nasal* surface. The lingual surface presents, along its middle, a white line, called the raphe; and from the centre of the velum there is seen a depending portion called the *uvula,* which divides it into two lateral halves. In the raphe is situated that congenital division of the velum called *cleft palate.* On either side of the uvula the velum presents two lateral curvatures, an anterior and posterior, called the *anterior* and *posterior lateral half arches.* The anterior half arches proceed from the base of the uvula, outward, having their concavity downward to the sides of the tongue. The posterior half arches, proceeding also from the uvula, pass downward and backward to the sides of the pharynx. The space between the anterior and posterior half arches is called the *fauces,* and is occupied by the *tonsils.* The opening

Fig. 88.

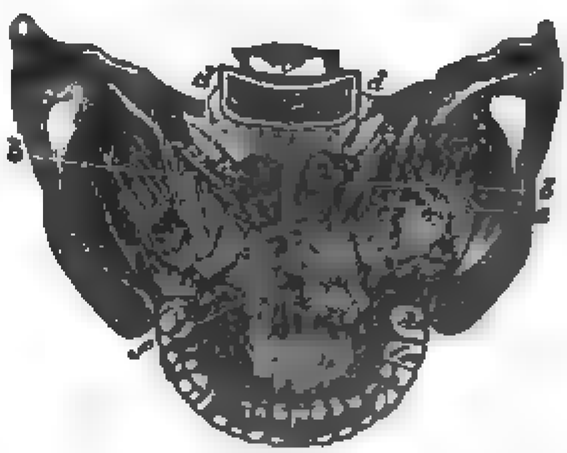


Fig. 88 represents the muscles of the Soft Palate. *a* Roof of the mouth; *b b* Levator palati; *c* Cuneiform portion of the sphenoid; *d d* Eustachian tubes; *e* Circumflexus, or tensor palati muscle; *f* Azygos uvulæ; *g g* Palato pharyngeus.

between the anterior half arches is the *isthmus* of the *fauces*.

The *tonsils* or *amygdalæ*, (αμυγδαλα, an almond,) situated as just stated in the fauces, consist of mucous follicles collected together in an almond-like shape, and vary much in size. In some they are scarcely seen—in others they fill up the whole fauces. Their inner surface is free, and full of foramina, which lead into the mucous follicles, that have been mistaken for ulcerations. Their external surface is covered by an aponeurosis, and the superior constrictor of the pharynx. They are very subject to inflammation, constituting quinsy or tonsilitis, and to chronic enlargements requiring extirpation. Their posterior surface corresponds to the angle of the jaw, and they are in relation in front with the facial artery, behind with the internal carotid, and on the outer side with the external carotid, separated by the superior constrictor of the pharynx, and some cellular tissue.

The *structure* of the soft palate consists, as stated, of an *aponeurosis*, *muscles*, *blood-vessels* and *nerves*, surrounded by mucous membrane.

The aponeurosis is a strong, dense, and fibrous tissue, regarded as continuous with the fibrous structure of the septum narium, the nasal fossæ and Eustachian tube, and constituting the frame work of the palate.

The *Muscles* (Fig. 88) of the soft palate are five pairs, i. e. the *levator* and *tensor palati*, *constrictor isthmi faucium*, *palato-pharyngeus*, and *azygos uvulæ*.

Dissection.—Open the pharynx from behind, by separating it from the cervical vertebræ, which remove, and then take off the mucous membrane of the palate, when its muscles will be exposed.

1. *Levator palati* is a moderately thick and round muscle, and *arises* in front of the foramen caroticum, from the extremity of the petrous bone, and back of the Eustachian tube, then descends by the side of the posterior nares, and is *inserted* broad into the soft palate as far as its median line. *Function*, to raise the palate.

2. *Tensor palati*, or circumflexus, is a slender muscle upon

the outside of the levator, and *arises* fleshy from a fossa at the root of the internal pterygoid plate, from the spinous process of the sphenoid bone, and front part of the Eustachian tube, and descends along the pterygoid plate, becoming a flat tendon as it reaches the hamulus, round which it turns. It finally expands by *inserting* itself into the aponeurosis of the palate, and according to some, into the hard palate also. *Function*, to spread the palate.

3. *Constrictor-isthmi-faucium* or *palato-glossus*, so called from its constricting or closing the opening to the fauces, occupies the anterior half arch of the palate and is in front of the tonsil. It consists of a small bundle of fibres, broader at the extremities than in the centre, *arises* from the lower surface of the velum, and descends to be *inserted* into the side of the tongue. *Function*, to raise the tongue, or depress the palate, and close the fauces.

4. *Palato-pharyngeus* occupies the posterior half arch of the palate, and *arises*, in common with its fellow, broad, from the lower surface of the velum, and passing downward and backward, behind the tonsil, is *inserted* into the pharynx at its side and back, between the middle and lower constrictors, and into the border of the thyroid cartilage. *Function*, to raise the pharynx as deglutition begins, and to depress the palate.

5. *Azygos-uvulæ* is not, as its name implies, a single muscle, but a pair of small symmetrical muscles, placed side by side on the median line, and *arising* from the posterior spine of the palate bone, or more correctly from the aponeurosis, continuous with the spine. It descends vertically to constitute the greater portion of the uvulæ. *Function*, to elevate and shorten the uvula.

Blood-vessels.—The arteries of the soft palate are the superior and inferior palatine branches of the internal maxillary and facial. The veins correspond with the arteries.

The nerves are the palatine branches of the superior maxillary of the fifth pair, coming from Meckel's ganglion, also branches from the glosso-pharyngeal.

THE TONGUE.

The *tongue* is arranged here among the organs of *deglutition*, though it performs a variety of other offices equally important in connection with other functions; as, for instance, it is concerned in prehension, suction, mastication, articulation, playing upon wind instruments, and is the special organ of taste.

It is an organ of motion, its great bulk consisting of muscular structure. It is an organ of sensation, both special and general, being most abundantly supplied with nerves; and it is also an organ of secretion; hence the importance of this body considered in any and every aspect. Its situation in the cavity of the mouth, and within the dental arch, in the state of rest, is familiar to all. It is kept in its position by ligaments and muscles, which attach it to the hyoid bone, the styloid processes and the lower jaw. It has, however, free motion at its tip and sides. The posterior portion, connecting it with the os-hyoides, is called its *base*, the middle portion the *body*, and the anterior part the *tip*. It has two surfaces, an upper and lower; the upper is called the *dorsum* of the tongue. Its *size* is very variable in different individuals, but is always in proportion to the curve of the lower jaw, and never fills the entire cavity of the mouth when the jaws are closed. The anterior and middle part is hori-

FIG. 89.

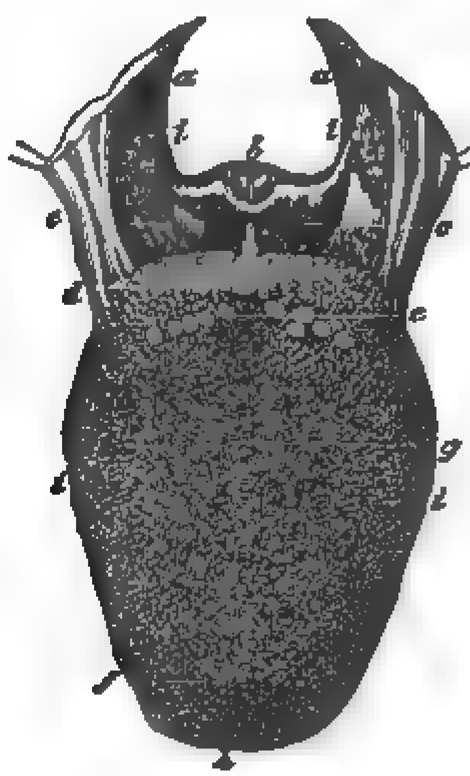


FIG. 89 represents a view of the Upper Surface of the Tongue. *a a* Posterior lateral half arches; *b* Epiglottis; *c c* Mucous membrane, extending from root of tongue to epiglottis; *d* Foramen cœcum of Morgagni; *e* Lenticular papillæ; *f* Papillæ filliformes; *g* Conical papillæ; *h* Point of tongue; *i i* Fungiform papillæ.

zontal, while the posterior makes a somewhat vertical bend down to the os-hyoides. This account of its direction is true when the tongue is kept within the mouth, but when it is protruded, the os-hyoides rises, and the whole is then on nearly the same horizontal level.

The *form* of the tongue is somewhat of an ellipse. Its *upper surface* or *dorsum* presents a very rough aspect from numerous eminences called papillæ, (papilla, a nipple.) These papillæ are various in size, and have received different names. Those at the base, arranged in the shape of the letter V, are the *papillæ maximæ.* (Fig. 89.) They are about nine in number, though as many as sixteen and twenty are mentioned. They are the largest in size, and present two rows, forming at their point of union a blind opening called the *foramen cœcum of Morgagni*, regarded as the receptacle of mucous secretion from the follicles. These papillæ maximæ resemble a cone, have their base above and free, while the apex is below and fixed in a cup-like cavity, whence they are also called *calyciformes.* Within this cup a fossa, or circular trench, is seen surrounding the papilla, from which also the name of *circumvallatæ* is derived.

The *papillæ mediæ*, or *fungiformes*, the next in size, are found irregularly scattered over the dorsum of the tongue, and some are seen at the tip. They are easily recognized by the rounded and flattened tops resting on a narrow pedicle, and having a direction backwards.

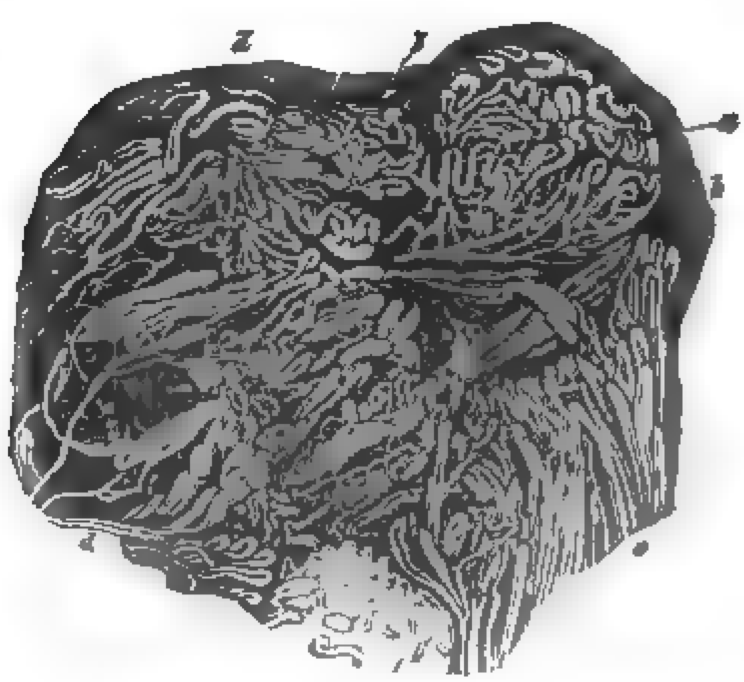
The *papillæ villosæ* or *conical*, and the *filiform*, are the smallest and most numerous; they cover the whole surface of the tongue, being scattered among all the others, and are most abundant at the tip.

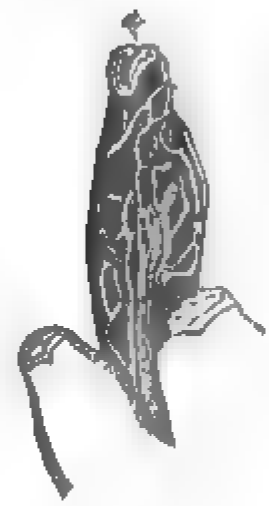
Blood-vessels of papillæ.—The microscope of Mr. Nasmyth discovers the elements of the papillæ to consist of capillary vessels and loops of terminal nervous filaments, connected by an areolo-fibrous tissue. The capillaries are found to proceed from a small artery running through the centre of the papillæ, (Fig. 90, B,) and then ending in a vein which returns along the course of the artery. A variety is observed

in the capillaries of the different papillæ—in those of the conical papillæ of the fœtus a coarse net-work is observed, and a vascular ring surrounding the apex of each papilla, giving the appearance of an aperture. In the filiform papillæ, the capillaries are seen as a single loop, (Fig. 90, A,) while in the papillæ maximæ or calyciformes, (Fig. 90, A,) they are more tortuous and of the plexus form.

Behind the papillæ maximæ some eminences are observed having the same arrangement as these papillæ. They

A FIG. 90. B





were formerly considered among the papillæ, but are now regarded as glands. They have perforations which are visible to the eye, and being found to have the same structure as the parotid, are considered salivary and not mucous glands.

The upper surface of the tongue has beneath its mucous coat a dense membrane, which resembles the corium of the skin, and is called the *papillary membrane* from its giving support to the papillæ. In some instances it is almost as hard as cartilage. It is divided along the median line by a

FIG. 90, A represents the Papillæ on a part of the surface of the Tongue of an adult, and shows the manner in which the vessels are distributed. *a* Papillæ maximæ or calyciforme. *b b* The groove around it. *c* Papillæ filiformes, or thread-like papillæ. *d* Conical papillæ.

FIG. 90, B represents a *conical Papilla*, having at its extremity *a* An aperture. The distribution of its vessels is also seen.

raphe, which is a vertical septum of ligamentous matter, making the tongue consist of two equal and symmetrical parts.

The anterior third of the tongue is the only portion free on its lower surface, all the rest being attached by muscles. On this surface is noticed, along its middle, a furrow from the posterior part of which a fold of mucous membrane passes to the posterior surface of the symphysis menti. This fold is called the *frenum linguæ*, and is the part concerned in the "tongue-tie" of children, where it is too short and requires division. The ranine veins are plainly seen on each side of this furrow.

Muscles of the Tongue.—The muscles of the tongue (Fig. 87) consist of four pair, which have been given at the beginning of this section, except one, the *lingualis*. This is the intrinsic muscle of the tongue, and consists of a slender fasciculus of fibres, *arising* indistinctly among the yellow cellular tissue at its base, and passing forward between the *hyo-glossus* and *genio hyo-glossus*, to the tip. Its fibres run in different directions—being transverse and vertical, as well as longitudinal; hence the terms *transverse lingual*, and *vertical lingual* muscles.

The superficial fibres of this muscle are closely connected with the dense papillary membrane or corium, which is a kind of skeleton upon which they, with the other fibres, act in effecting changes both in the form and density of the tongue. Thus, by means of this extensive muscular apparatus, the tongue has the power of moving in every possible direction—of keeping the food beneath the teeth, and of passing it from the mouth into the pharynx—thereby performing a most efficient part in mastication, as well as deglutition.

Blood-vessels of the Tongue, (Figs. 73, 91.)—The arteries come principally from the lingual, a branch of the external carotid, and injections seem to show that the arteries belonging to either half of the tongue advance to its vertical septum, and then stop—those of the one side having no anastomosis with those of the other, being effectually pre-

The *muscles* (Fig. 92) cover the back and sides of the pharynx in one uniform membranous sheet or layer, and are called *constrictors*. They are three in number, the *inferior*, *middle*, and *superior constrictors* of the pharynx. These are symmetrical muscles, lying upon either side, and connected with the tendinous line or raphe, which runs along the centre of the back part of the pharynx.

Constrictor pharyngis inferior, *arises* from the inferior cornu, and posterior ala of the thyroid cartilage, and from the side of the cricoid. Its fibres radiate, (some ascending, and others transverse,) to be *inserted* into the raphe on the back of the pharynx, along with its fellow. The superior fibres overlap the middle constrictor. The superior laryngeal nerve passes along the upper, and the inferior laryngeal beneath the lower border of this muscle.

Constrictor pharyngis medius—partly covered by the last, and of a triangular shape, *arises* from the appendix and cornu of the os-hyoides, and from the posterior thyro-hyoid and styloid ligaments. Its fibres ascend, run transversely, and descend. It is inserted into the mesial line, and by its ascending fibres, into the cuneiform process of the occipital bone.

Constrictor pharyngis superior is above the last, and separated from it by the *stylo-pharyngeus* muscle, and glosso-pharyngeal nerve. It surrounds the upper and posterior part of the pharynx, and *arises* from the internal pterygoid plate, from the upper jaw, behind the last molar tooth; from the pterygo maxillary ligament; from the side of the base of the tongue, and from the posterior portion of the mylo-hyoid ridge. From this extensive origin, the fibres proceed backwards and upwards, and are *inserted* into the middle line, and cuneiform process of the occipital bone.

Function.—The constrictor muscles are the prime agents in deglutition, and conduct the food, by their successive contractions, from the pharynx into the œsophagus.

Stylo-pharyngeus is a slender muscle *arising* from the root of the styloid process. It passes to the side of the

pharynx, between the upper and middle constrictors, and is *inserted* into the cornu and posterior margin of the thyroid cartilage.

Function.—To raise, dilate, and shorten the pharynx, so as to receive the food. It will also elevate the larynx.

The middle coat consists of cellular tissue, called the pharyngeal aponeurosis, which is stronger along the middle line where it gives attachment to the constrictor muscles, than elsewhere, and is the connecting structure between the outer or muscular, and mucous or internal coat. This coat, being a continuation of that lining the cavity of the mouth, will be considered in connection with it.

Cavity of the Pharynx.—*Dissection.*—Make an incision through the middle tendinous line on the back part of the pharynx, and this cavity will be exposed. In front will be seen the *velum* and *uvula*, and opening into it will be noticed seven foramina; at its upper part are the two posterior nares, on each side of these are the Eustachian tubes, in front is the isthmus of the fauces, and below we see the glottis, and the commencement of the œsophagus. The Eustachian tubes are found at the posterior part of the inferior turbinated bone, and as just stated, on each side of the nares. Their mouth is circular, and large enough in most cases to admit the end of the little finger. They lead to the ear, and conduct the air from the pharynx into the cavity of the tympanum. Their direction is upwards, outwards, and backwards to the tympanum, occupying in their course the pterygoid fossa, and having in two-thirds of their extent a thick cartilaginous structure, the balance being composed of bone. These tubes are lined by the mucous membrane continued from the pharynx, and when this is inflamed they become thickened and obstructed, this being a frequent cause of deafness.

Blood-vessels, (Fig. 73.)—The arteries supplying the pharynx are the superior and inferior pharyngeal, the former a branch of the internal maxillary, the latter a branch of the external carotid. The palatine and superior thyroid

also send some small twigs. The veins, after forming the *pharyngeal plexus*, return into the jugular and superior thyroid.

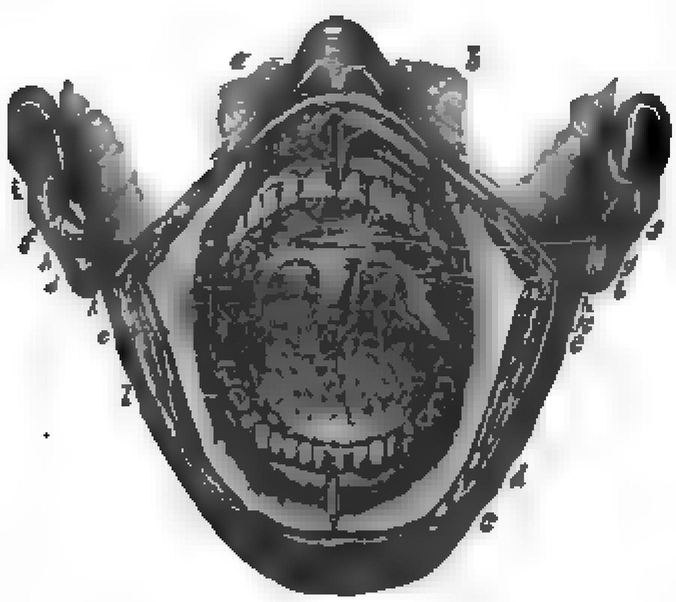
Nerves.—The nerves of the pharynx are the *glosso-pharyngeal*, (Fig. 91,) the *pharyngeal* branch of the par vagum, all belonging to the eighth pair, and branches from the superior cervical ganglion of the sympathetic.

SECTION IX.

THE MOUTH.

The *mouth*, (Fig. 93,) situated at the commencement of the digestive tube, is composed of the organs of *prehension*, *mastication*, *insalivation*, and part of those of *deglutition*. Hence it is evident that it consists of an apparatus both complicated and various. Having considered all the organs forming the mouth, successively and in detail, it now seems proper to look at them for a moment collectively in their several *relations* to the mouth as a whole, and in their united and harmonious action in the discharge of the various functions they are called upon to perform.

Fig. 93.



The cavity of the mouth is bounded superiorly by the palatine processes of the *superior maxillary* and *palate* bones, which constitute its roof; inferiorly by the *mylo-*

Fig. 93 represents a view of the cavity of the mouth. *a* Superior lip turned up. *b* Frænum of the upper lip. *c* Inferior lip turned down. *d* Frænum of the lower lip. *e e* Internal surface of the cheeks. *f f* Point where the duct of steno enters the mouth. *g* Roof of the mouth. *h* Anterior portion of the lateral half arches. *i* Posterior portion of the lateral half arches. *j* Velum pendulum palati. *k* Tonsils. *l* Tongue.

hyoid muscles, forming the floor; anteriorly by the lips; posteriorly by the *soft palate*, and laterally by the *cheeks*.

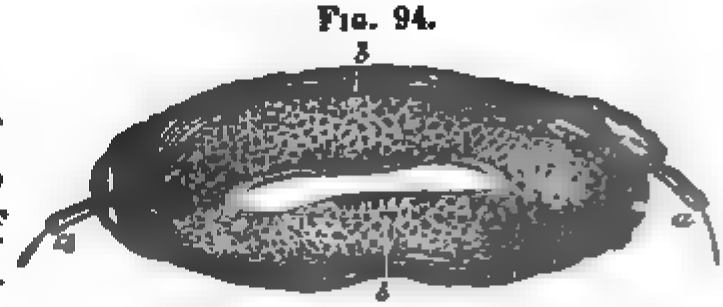
Dissection.—To expose the cavity of the mouth, make an incision through its angles, carried laterally through the cheeks, dividing the buccinator, masseter and insertion of temporal muscles; then, in sawing through the lower jaw on one side, the cavity will be fully laid open for examination.

The tongue, teeth, gums, velum, uvula, tonsils, and sublingual glands, are some of the contents already described of this cavity; the whole of which, as well as the cavity itself, has one common covering, i. e. the mucous membrane of the mouth, which extends into the pharynx, and is continuous with the great gastro-pulmonary mucous membrane.

The mucous membrane of the *mouth* and *pharynx* has already been considered in a general way in the description of this elementary tissue, under the head of alphabet of anatomy. But there are some modifications in its course, not there mentioned, which require notice.

It will be recollected that mucous membrane is usually soft, pulpy, easily torn, and when deprived of blood, of a pale, grayish, or ashy hue. Now, in the mouth and on the lips this membrane has considerable firmness, and presents a distinct epithelium, corresponding to the cuticle of the skin. The nucleated cells of which this epithelium is at first composed, as they advance to their full development gradually lose their nuclei and present the form of scales, so that the epithelium of the mouth is called *squamous*.

FIG. 94.

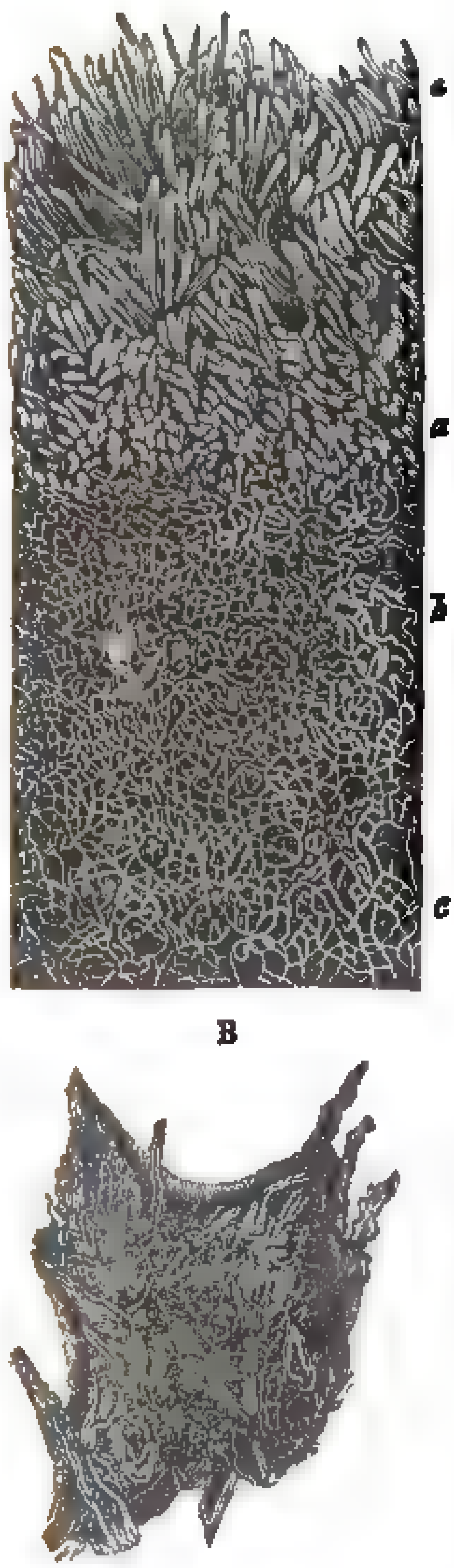


As the mucous membrane passes from the posterior surface of the lips to the front portions of the alveolar processes of the upper and lower jaw, it is folded or duplicated,

FIG. 94 represents a view of the inner side of the Lips. *a a* Ducts of Steno or parotid ducts. *b b* Labial glands.

and these folds receive the name of *frena* or bridles of the lips. Beneath the mucous layer of the lips are situated the *labial glands.* These consist of small spheroidal granules. Like the parotid and the rest of the salivary glands, they lie close to each other, but are distinct, and have each a distinct excretory duct, and open by a separate orifice on the posterior surface of the lips. Hence they are regarded as true *salivary*, and not mucous glands, (Fig. 94.)

Fig. 95. A



The vascularity of the lips, as shown under the microscope of Mr. Nasmyth, is exhibited in Fig. 95. A represents a part of the mucous membrane on the inner side of the upper lip of a fœtus, minutely injected, magnified 40 diameters. *a a* Papillæ, which become smaller towards the middle of the figure. *b* Capillaries forming a plexus with small meshes. *c* The capillary plexus coarser, the meshes larger and corresponding to the situation of the submucous glands. B also magnified 40 diameters, represents a portion of the *free edge* of the upper lip of a human fœtus, and shows the manner in which the capillaries are arranged in the papillæ.

The mucous membrane in passing from the lips over the alveolar processes, to get behind the teeth, undergoes a most remarkable and important change, being transformed into the gums.

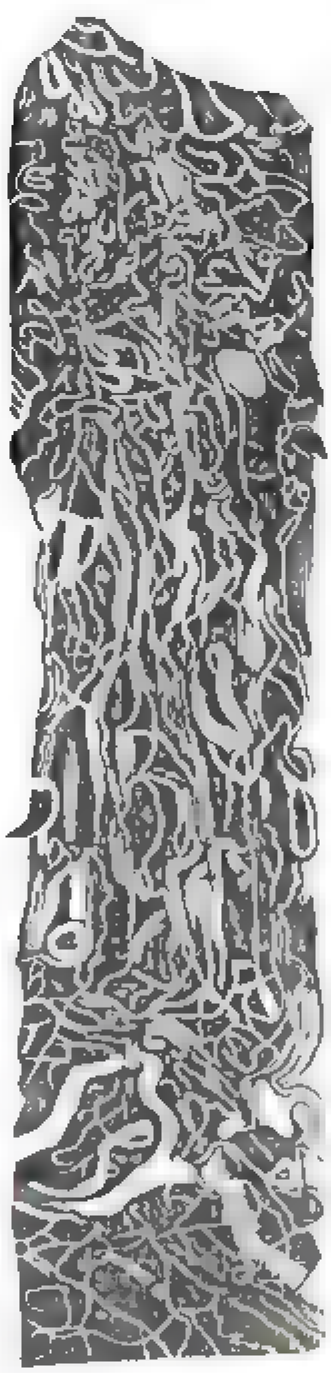
The gums are distinguished by their thickness, by their density, being almost cartilaginous; by their intimate adhesion with the periosteum of the alveolar processes; and by their strong attachment to the necks of the teeth. The vascularity of the gums, as developed by Mr. Naesmyth's microscope, is seen in the annexed figure.

A represents the papillæ of a part of the gum of an adult, minutely injected, magnified 38 diameters, and shows the tortuous course of the capillary vessels.

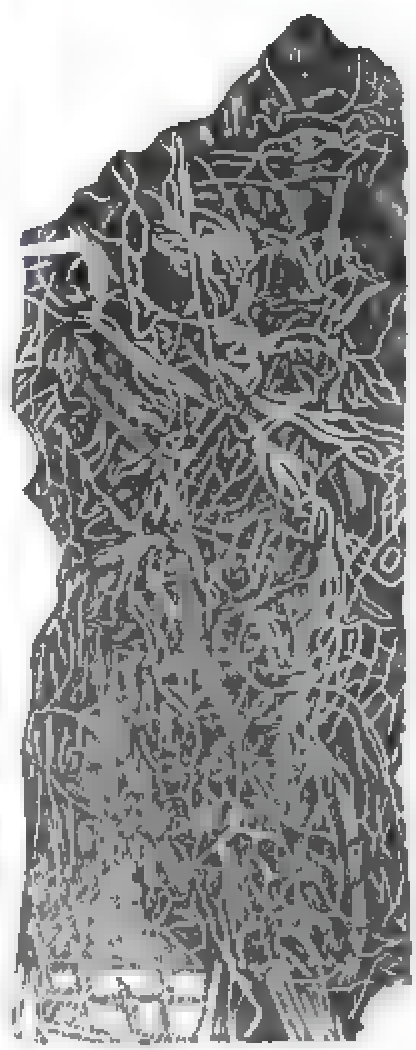
B represents a part of the gum and adjacent mucous membrane of the human fœtus, magnified 100 diameters. In the lower part of the figure are seen the plexuses formed by the larger vessels; and in the upper part are seen the papillæ.

Fig. 96. A

B



C



C shows a portion of the mucous membrane of the gum and palate of the human fœtus, minutely injected and magnified 75 diameters. The deeper vessels are the largest, and the spaces in the superficial plexus correspond to the situation of the submucous glands.

The gum is traced from the neck of the tooth into the alveolar cavity, as continuous with, and constituting the *alveolo-dental periosteum.* In the infant state the gums present on their superior edge a dense, white, cartilaginous ridge, which becomes thinner and thinner as the period of eruption approaches. The failure to undergo this thinning process is the not unfrequent cause of great irritation and even of convulsions in teething. In the tissue of the gums, mucous follicles are found, which have been mistaken for glands furnishing the tartar, and have hence been called *tartar glands.* But it is now settled that the tartar is simply a deposit of calcareous matter from the saliva.

Alveolo-dental periosteum.—This membrane is fibrous in structure—is attached to the necks of the teeth—lines the alveolar cavities—covers the roots—is connected to the blood-vessels and nerves, where they enter the apices of the teeth, and is believed by Mr. Bell, to enter the cavities of the teeth, lining their interior walls, and being continuous with, or the same as that of the pulp.

It has just been stated that this membrane is believed to be continuous with that of the gums. Others think that the sac containing the pulp, which consists of two coats, after the eruption of the teeth, forms (especially the outer coat) this alveolo-dental periosteum; while Mr. Bell, on the other hand, believes that the sac is entirely absorbed, and that this membrane is the same as the *periosteum,* covering the superior and inferior maxillary bones, continued into the alveolar cavities, and from thence reflected on the roots of the teeth. This membrane is important in maintaining the teeth in their sockets.

In tracing the mucous membrane from the gums, we next find it covering the roof of the mouth, the soft palate, the interior of the cheeks, the tongue, and thence follow it into the pharynx.

The mucous membrane, covering the roof of the mouth, is characterized by the thickness of its epithelium, the density of its chorion, its strong adhesion to the bone, its whitish color; and the numerous orifices noticed in it,

especially at its back part. On the median line of the palatine arch, the mucous membrane is most strongly attached to the periosteum—while on either side of this line there is interposed a thick layer consisting of glands. These glands are found to be sometimes disposed in regular rows over the palatine arch, and from their being like the labial and parotid, are called the *palatine salivary glands*. They are in greater numbers behind than in front, and open by many orifices which are visible to the eye.

The mucous membrane, lining the *cheeks*, is a continuation of that belonging to the lips, already described. There is also, beneath it, a layer of glands of the salivary order, which cause projections on its surface, and are called the *salivary buccal glands*. They are precisely like the labial, though smaller, and open by distinct orifices. Two of these glands, from not being situated directly beneath the membrane, but placed between the buccinator and masseter muscles, are called the *molar glands*. Their ducts open opposite the last molar tooth.

The mucous membrane of the *soft palate* is remarkable for its upper or nasal surface presenting the columnar arrangement in its epithelium, while the lower or lingual surface has the squamous form of the mouth.

The mucous membrane of the pharynx has a reddish appearance, and is characterized by its density and close adhesion to the periosteum upon the basilar process. It forms a rim around the mouth of the Eustachian tube, and becomes thinner as it traverses the tube towards the cavity of the tympanum.

This relation established between the nose and throat, and the Eustachian tubes, by the continuity of the same mucous membrane into these several parts, is regarded as the cause of that deafness which occurs from obstruction in these tubes during coryza and chronic sore throat.

Blood-vessels of the Mouth and Pharynx, (Fig. 73.)—The *internal maxillary*, *facial*, *lingual*, and *pharyngeal* arteries, all branches of the *external carotid*, are the principal sources whence the mouth and pharynx, with all their organs, are

supplied. They have been already detailed. The veins have corresponding names and situation with the arteries, and terminate in the jugular.

The nerves (Fig. 74, 91, 97) supplying the mouth and pharynx come from the fifth, the seventh, eighth, and ninth pair of the cerebral nerves, and from the sympathetic system.

CHAPTER III.

ORGANS OF EXPRESSION.

These comprise the muscles concerned in giving *expression* to the various passions, which are chiefly the *occipito frontalis*, *corrugator supercilii*, *pyramidalis nasi*, *compressor-nasi*, and *orbicularis palpebrarum*, (Fig. 55.) The *facial nerve* (Fig. 97) must also be included in the organs of expression, as it is the motive power of the muscles.

Occipito-frontalis.—Dissection.—Commence an incision from the root of the nose, and carry it through the integument, along the median line of the cranium, as far back as the tuberosity of the occipital bone. Make a second incision parallel with, and about half an inch above the eyebrow, and connect it with the first. Make a third incision from the posterior extremity of the first, upon either side of the occipital protuberance, along the superior transverse ridge of this bone. Commence dissecting off the integuments at the transverse incision, and this muscle will be exposed. The adhesion between this muscle and the scalp is very close, and this, added to the paleness of its fibres, makes the dissection both difficult and tedious, requiring caution and perseverance to succeed. The scalp being removed, this muscle is seen to consist of four fleshy bellies—two anterior covering the forehead, and two posterior investing the occiput, with an intervening and expanded aponeurotic structure, covering the superior and lateral portions of the cranium. It arises by two fleshy bellies, with tendinous fibres, from the superior transverse ridge of the

occipital bone, and from the mastoid process of the temporal. The fibres ascend, and soon terminate in one broad sheet of tendon, called the *epicranial aponeurosis*, which spreads over the superior and lateral parts of the cranium, as far forward as the coronal suture, where it again becomes fleshy, forming the two anterior bellies which are inserted into the skin of the eyebrow, and mingle their fibres with those of the corrugator supercilii, and orbicularis palpebrarum muscles.

This muscle is regarded by some as a digastric muscle—by others, as quadriceps—two frontal and two occipital muscles, having, in either case, the central aponeurosis as their common point of insertion. There extends down from this muscle a fleshy slip along the nasal bones, which is attached to the internal angular process of the frontal bone. It is considered as a distinct muscle, and called the *pyramidalis nasi*, or *fronto nasalis*.

This muscle is loosely connected to the cranium, but closely to the scalp. *Function*—to elevate the eye-brows and throw the forehead into transverse wrinkles; to raise the upper lids and expose the ball of the eye as in staring; and to draw the scalp either backward or forward as the anterior or posterior bellies become the fixed points of action.

Corrugator Supercilii, (Fig. 55.)—*Dissection*.—Turn down the integument of the eyebrow from the transverse incision of the frontal muscle, beneath which this muscle will be seen. It *arises* from the internal angular process of the os-frontis, and proceeds upward and outward between the occipito frontalis, and orbicularis palpebrarum, to be *inserted* into these and the middle of the eyebrow.

This muscle is said to be peculiar to man alone, and to be found in none of the inferior animals. It is connected largely with expression, and the exhibition of mental operations.

Function.—To draw the eye-brows towards each other as in frowning, and to throw the forehead into vertical wrinkles.

Compressor nasi, (Fig. 55,) a small, thin, triangular

muscle, *arising* from the canine fossa of the upper maxilla, and then spreading over the ala nasi, is *inserted* along with its fellow upon the dorsum of the nose, by a thin aponeurosis.

Function.—It can either compress or dilate the nostril, as one or the other of its attachments becomes the fixed point of action. In panting, as in violent respiration after running, as seen in the horse, this muscle becomes a powerful dilator, and has received the name of the *dilator nasi.*

Orbicularis palpebrarum, (Fig. 55.)—*Dissection.*—The same incision for exposing the corrugator supercilii, being carried round the lower margin of the orbit to the inner canthus of the eye, also exposes this muscle as well as the compressor nasi.

It *arises* fleshy from the internal angular process of the os frontis, and upper edge of the *tendo oculi*—its fibres then proceed upward and outward, broad and thin, along the upper edge of the orbit and tarsal cartilage, describing curves in their course to the external commissure of the eyelids; from this it is continued round in similar curves upon the lower edge of the orbit and lower eyelid to the internal canthus of the eye, where it is *inserted* into the nasal process of the superior maxilla, the inner third of the edge of the orbit, and the lower edge of the *tendo oculi.* The *tendo oculi* or *tendo palpebrarum* is a short, horizontal tendon, about a quarter of an inch in length, attached to the superior end of the nasal process of the upper maxilla, and extending thence transversely to the inner canthus of the eye, where it is distinctly felt. At this point it forks; the divided portions enclose the caruncula lachrymalis and are connected with the tarsal cartilages and lachrymal duct. This tendon also passes across the lachrymal sac, and sends off a strong aponeurosis which covers its anterior surface.*

Function.—To close the eyelids, which is done by the fibres of this muscle being drawn in a straight line.

* The palpebral portion of this muscle, running along the margin of the eyelids, is called the *Ciliaris Muscle.*

CONJOINT ACTION OF THESE MUSCLES IN EXPRESSION.

If the *orbicularis palpebrarum* and *pyramidales nasi* act together, the expression is "heavy and lowering." If these yield to the influence of the *frontal*, the eyebrow is arched and the expression is "cheerful and inquiring." If the *corrugator supercilii* act, it is said by Mr. C. Bell to indicate "more or less of mental anguish, or painful exercise of thought." If it combine its action with the frontal portion of the *occipito-frontalis*, the eyebrow is drawn upwards, and the forehead wrinkled, giving an expression more of "weak anxiety and querulousness."

The *compressor nasi*, in conjunction with the *levator labii superioris alæque nasi*, and *depressor nasi*, by compressing, depressing and expanding the nostrils, indicate "general excitement and animal activity, and give spirit to the whole countenance."

It may be proper to notice in this connection that all the muscles attached to the mouth are also muscles of expression, though they have been described in another place under the head of *prehension*. We will only notice, further, in reference to their relations with expression, that when the *orbicularis oris*, or sphincter muscle of the mouth, contracts, while the lateral, or *zygomatic* muscles are in action, there is "a painful and bitter expression." If, on the contrary, the *orbicularis* of the mouth be relaxed, while the *orbiculares* of the eyelids are contracted, then, by the action of the lateral muscles, there is produced a "cheerful and smiling expression of the countenance."

The *depressor anguli oris* is said to be, like the corrugator supercilii, peculiar to man; and when it combines its action with the *levator menti* produces "the most contemptuous and proud expression."

The eye is also full of expression, and so are other portions of the body, all of which will be examined in their appropriate places.

Nerve of Expression, Fig. 97, (*the facial nerve*,) called also the portio-dura of the seventh pair, is the great nerve of

expression and motion to the face, and is one of the respiratory nerves of Sir Charles Bell. It arises from what is termed by this latter gentleman, the respiratory tract, and from that particular portion of this tract, lying between the *corpus olivare* and *corpus restiforme*, at the upper part of the medulla oblongata, and near the pons, whence its fibres are traced into the corpus restiforme. It is smaller than the auditory nerve, and anterior and superior to it in the meatus auditorius internus, where they both enter, and where they interchange connecting filaments. After the facial nerve traverses the auditory meatus, at the bottom of this latter, it enters the aqueduct of Fallopius—pursues the course of this canal, which is between the cochlea and vestibule, and behind the tympanum—proceeds, first, horizontally backward, then outward above the fenestra ovalis, and descends along the inner wall of the tympanum, to the stylo mastoid foramen, at which it emerges. From this point it proceeds forward in the substance of the parotid gland, crossing the external carotid artery, and external jugular vein, to the ramus of the lower jaw, behind which it divides into two branches called the temporo-facial, and cervico-facial. Opposite to the hiatus Fallopii, the Vidian

Fig. 97.

Fig. 97 represents the *Facial nerve*, or Portio-dura of the seventh pair. *a* Trunk of the facial nerve, *b* Ascending branch. *c* Descending branch. *d* Posterior auricular branch. *e e* Temporal branches. *f f* Malar branches. *g g* Inferior maxillary branches. *h* Occipital nerve. *i* Terminal branches of the inferior dental. *j* Terminal branches of infra orbital. *k k* Supra orbital nerve and branches. *l* Orbicularis oris muscle. *m* Zygomaticus major. *n* Zygomaticus minor. *o* Levator labii superioris alæque nasi. *p* Orbicularis palpebrarum. *q* Depressor anguli oris.

nerve, from the ganglion of Meckel, joins the facial. At this point of junction there is seen a gangliform expansion, receiving filaments from the sympathetic, and from the otic ganglion of Arnold. Here the Vidian nerve separates from the facial, and enters the cavity of the tympanum at its superior and posterior portion, becoming, at this point, the *chorda tympani*, which crosses the cavity of the tympanum obliquely forward and downward, between the handle of the malleus and long leg of the incus, escapes through a foramen on the inner side of the fissure of Glasser, and joins the gustatory nerve, at an acute angle, between the pterygoid muscles. At the angle of the jaw, it leaves the trunk of the gustatory, and goes to the submaxillary ganglion, where it terminates. The chorda tympani has been considered, by some anatomists, a branch of the facial; but Mr. Jno. Hunter appears to have satisfactorily demonstrated the Vidian to be the recurrent branch of the second division of the fifth pair, and consequently a nerve of sensation. From the circuitous route of the Vidian, it is seen to establish several very interesting connections. It connects the ganglion of Meckel with the superior cervical ganglia, by filaments which unite with sympathetic filaments in the cavernous sinus, before entering the hiatus Fallopii; unites Meckel's ganglion with the submaxillary ganglion—connects the superior and inferior maxillary nerves together, and further unites both these with the facial.

The branches of the facial are, 1. *Tympanic*, one or two small filaments in the cavity of the tympanum, to supply the stapedius and tensor tympani muscles. 2. Three branches, just as it emerges from the stylo-mastoid foramen, the posterior *auricular*, the *stylo-hyoid*, and *digastric*, supplying the back of the ear, the stylo-hyoid, and digastric muscles. 3. In the substance of the parotid, the *temporo-facial* and *cervico-facial*, terminating branches of this nerve, which send off numerous filaments that connect and interlace, so as to form a plexus, called the *parotidean plexus*, or *pes anserinus*. The *temporo-facial* ascends over the neck of the lower jaw, to be distributed

over the temple and upper portions of the face, by branches termed *temporal*, *malar*, and *buccal*, which anastomose with the auricular branch of the inferior maxillary, the supra orbital, and infra orbital nerves.

The *cervico-facial* descends, supplying the lower portions of the face, and upper portions of the neck, by branches called the *maxillary*, *submaxillary*, and *cervical*, which communicate with the mental nerve and ascending filaments of the cervical plexus.*

Blood-vessels.—The arteries supplying the organs of expression, come from the facial, transverse facial, occipital, temporal, and internal maxillary of the external carotid, and from the ophthalmic of the internal carotid artery, (Fig. 73.) The veins correspond to the arteries—those of the external carotid go to the jugulars—those of the internal carotid, to the cavernous sinus.

CHAPTER IV.

ORGANS OF SENSE.

Sensation is defined to be a "change in the condition of the mind, by which we become aware of an *impression* made upon some part of the body," or it is styled the "consciousness of an impression."

Organs of *sense* are the instruments of receiving the impression, through which a corresponding change in the

* Another view of this complex nervous arrangement may be taken. According to many excellent observers, there are three divisions of the seventh nerve, instead of two. The *portio mollis*, or auditory, and the *portio dura*, or facial, have lying between them, from their very origin, a set of filaments which can be dissected from them, and shown to unite in a nervous trunk of a reddish color, strongly contrasting with the pure white tint of the facial. This *portio intermedia*, as it has been called, can be traced closely connected with the facial, following it into the aqueduct of Fallopius, and sending filaments to both it and the auditory, and finally losing itself in the geniculate ganglion, called, also, *intumescentia gangliformis*, or *genuformis*. This geniculate ganglion also receives the two petrosal nerves, one of which is a branch of the Vidian,

mind, called sensation, is effected. The organs of sense are divided into *external* and *internal*. The former comprise the eye, the ear, the tongue, the nose, and the skin, performing the functions of seeing, hearing, tasting, smelling, and touch. The latter division of internal sensation includes the brain and nervous system.

SECTION I.

THE EYE.

The organ of vision consists of the *eye proper* or *ball*, and of the *appendages* of the *eye*, or *tutamina oculi*.

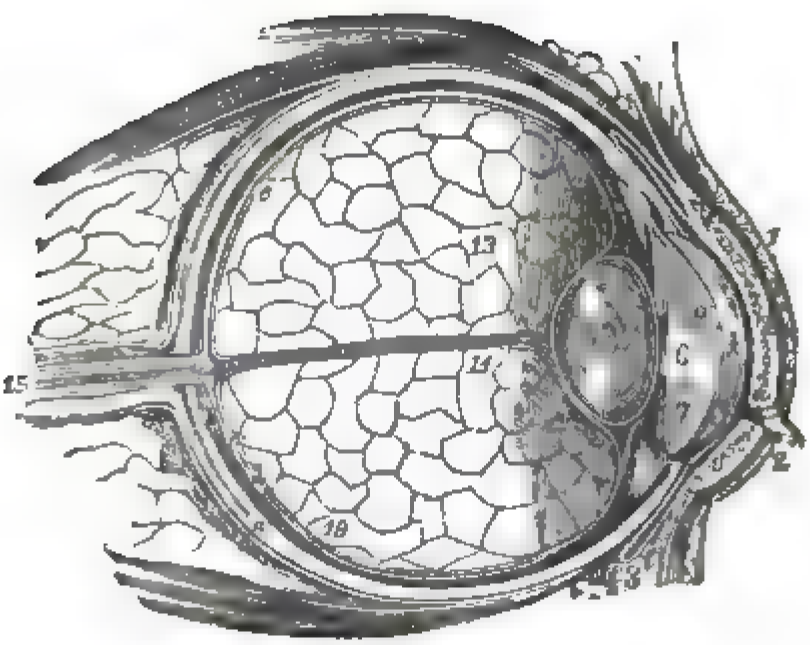
The ball or globe of the eye furnishes an example of the most perfect of optic instruments, and the most surprising adaptation in all its parts, for the purposes of vision. It, in fact, combines the properties of both the microscope and telescope, being constructed to view objects both near and at a distance, and having special relation to the stimulus of light.

The eye is *situated* in front of the bony orbit—resting upon an elastic cushion of fat, which allows it great mobility, and which, from its quantity, whether great or small, will cause a proportionate projection or retraction; so as to give the appearance of either large or small eyes, though, in fact, the eye may not vary absolutely in size.

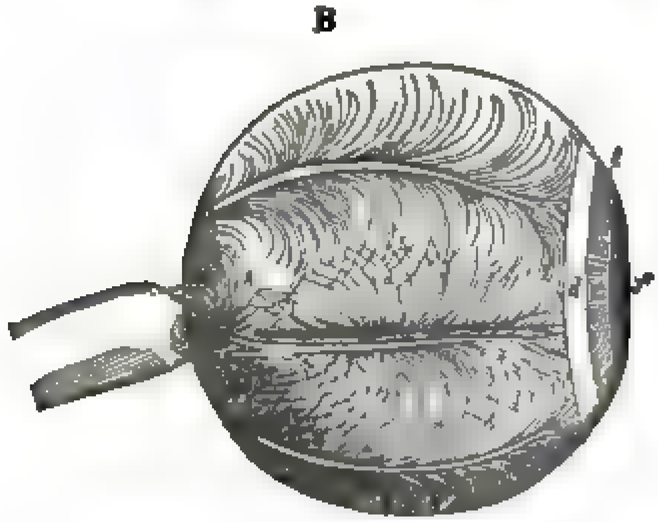
It is surrounded and retained in its situation by muscles, vessels, nerves, the conjunctive membrane and the eyelids. Its *form* is nearly a sphere; the antero-posterior diameter being somewhat the longest on account of the projection

and the other is connected with the otic ganglion and with Jacobson's nerve. Regarding this ganglion as a nervous centre, then, we have, entering into it, filaments from the seventh, eighth, fifth, and sympathetic nerves. The chorda tympani springs from it, crosses the tympanum, as already described, lies close to the gustatory, and finally is, according to some anatomists, distributed to the lingualis muscle; according to others, connected with the submaxillary ganglion. We have already alluded to this complex relationship, and have called attention to the opinion of Malaguti, that this *portio intermedia* is a sympathetic nerve, entering the substance of the brain, and uniting a very great diversity of organs by its numerous connections.

FIG. 98. A



B



of the cornea and measuring about one inch. The axes of the eyes are parallel to each other, but not to that of the bony orbit.

The eye is a hollow sphere composed of a membranous case, and four *refractive lenses* or media of light. The case consists of three coats or membranes, an outer, middle and inner, called the *sclerotic*, *choroid*, and *retina*.

Tunica Sclerotica, (Fig. 98, A,) (σκληρος, hard.)—*Dissection.*—Clean the ball of all its attachments, which is best done with the scissors, while the eye rests in a shallow dish of water.

This membrane forms the whole of the outer coat of the eye, except its front part, which receives the cornea. Its

FIG. 98, A represents a section of the Eyeball. 1 Upper lid. 2 2 Meibomian glands. 3 Reflection of tunica conjunctiva. 4 Cornea. 5 Anterior chamber of the aqueous humor. 6 Pupil. 7 Iris. 8 Crystalline lens. 9 Ciliary processes. 11 Canal of fontana. 12 Canal of petit. 13 Section of the vitreous humor. 14 Central artery of the retina, passing through the vitreous humor. 15 Optic nerve. *a* Sclerotic coat. *b* Choroid. *c* Membrane of Jacobs. *d* Retina. *e* Hyaloid membrane.

FIG. 98, B represents the Choroid coat, or second tunic of the Eye. *a* Choroid. *b b* Ciliary nerves. *c* Long ciliary artery. *d* Ciliary ligament. *e* Iris, showing its two sets of fibres—the circular and radiating. *f* Pupil.

extent consequently reaches from the optic nerve to the circumference of the cornea. It is a pearly white, dense, very strong, inelastic fibrous membrane, designed to preserve the shape of the eye, and protect the delicate structures within.

The *external surface* is perforated round the optic nerve, which enters at the posterior part, with many small foramina for the passage of the ciliary vessels and nerves. It is covered by the tunica conjunctiva, with which it is loosely connected by cellular tissue, and gives insertion to several muscles. Divide this membrane circularly from its centre and reflect it forward towards the cornea, and backward to the optic nerve, carefully raising it from the choroid, so that its *internal surface* and density can be examined.

The internal surface of the sclerotic, presents a brown color, and is attached by delicate filamentous tissue, and by the ciliary vessels and nerves to the choroid, which gives this surface a rough appearance, but when these connections are removed, which can be readily done, it presents a smooth and glossy surface, from which it is said a serous layer can be dissected. This surface also exhibits the openings for the ciliary vessels and nerves which enter externally.

The density of this coat is greatest behind, and becomes gradually thinner as it approaches the centre; which, however, in front of this is again increased in thickness by the tendinous addition of the *recti muscles.*

It is perforated behind by the optic nerve, about one line and a half internal to the antero posterior axis. The portion of the sclerotic where the optic nerve enters, presents a cribriform appearance, and is called *lamina-cribrosa,* having its edges beveled, and containing a groove for the reception of the cornea. The outer layer of the sclerotic overlaps the cornea, and the union of the two is most intimate.

Structure.—The sclerotic is regarded as one of the strongest fibrous membranes of the body, having its fibres interlacing in every direction, and not capable of being separated into any true laminæ. It is continuous with the sheath of

the optic nerve, which is derived from the dura mater. In the normal state it possesses little sensibility, though when attacked with inflammation, it gives the most intense pain. Its nerves and vessels come from the ciliary branches.

Choroid coat, (Fig. 98, B.)—This membrane forms the second tunic of the eye. It is situated beneath the sclerotic, and connected to it by cellular tissue, vessels and nerves. It rests upon, but does not adhere to the retina. It *extends* from the optic nerve behind, to the ciliary ligament in front, which latter corresponds to the place of junction between the sclerotic and cornea. In a word, it lines and is coextensive with the inner surface of the sclerotic.

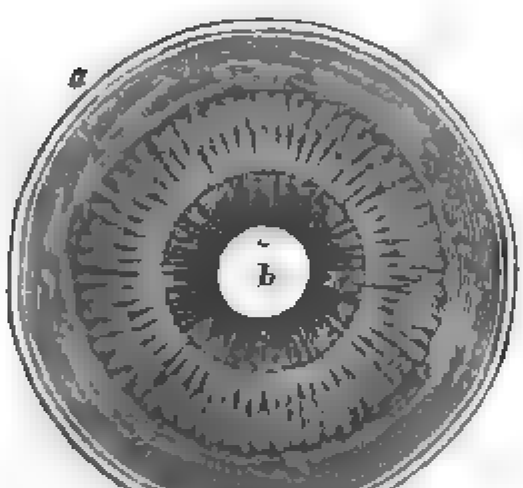
Its posterior surface is pierced by the optic nerve. Its anterior portion presents a large opening for the reception of the iris. Its *color* is of a dark brown on the external surface, while its inner surface is of a deep-black. Its *structure* is soft and extremely vascular. It has been divided into three layers, an external or venous, a middle or arterial, and an internal or pigmentary. Such a division is very justly regarded as of little utility, since it is purely artificial. This coat is, in fact, but one membrane highly organized and vascular. It is believed to equal in vascularity any of the mucous membranes, and has upon its outer surface a number of large veins, which from their peculiar arrangement are called *vasa vorticosa*, and constitute what is called the first layer; beneath this is seen a beautiful net-work of arterial capillaries, called after Ruysch, the tunica Ruyschiana. It is composed of the ciliary arteries and nerves, which penetrate the choroid from behind in great numbers, round the optic nerve and supply this tissue. The longer ciliary arteries, with the nerves, pass on to the ciliary ligament, and through it to the iris, to which organ the nerves seem chiefly destined. Beneath this arterial layer, the microscope reveals a delicate membrane, forming the internal lamina of the choroid, composed of nucleated hexagonal cells, disposed in several lamina, and containing the black pigment. This is the pigmentary membrane.

This pigment pervades the whole of the choroid, but is found to be more abundant on its internal, than on its external surface; and more abundant and of a deeper color, posteriorly and anteriorly, than laterally. The sclerotic is stained by the pigment. It is of deeper color in the child, and paler and less in quantity in the old. It is entirely wanting in Albinos, and vision is in consequence defective.

This pigment is wanting in the bottom of the eye of many of the inferior animals, as the sheep, ox, &c., and in place of it there is seen a beautiful, shining, metallic surface called *tapetum*. The *use* of the pigment is to darken the interior of the eye, to absorb the superfluous rays of light, and prevent their being reflected back upon the retina. For the same reason the interior of the telescope is blackened.

There are other parts however, besides the choroid, which have this black pigment, and which being also in close connection with it, will now be noticed. These are the *ciliary processes* and *iris*, (Fig. 99.)

FIG. 99.



There is a circular band about a line and a half broad, called the *ciliary ligament*, (Fig. 98, B,) which serves to connect together the sclerotica, cornea, choroid, and iris. It is of a fibro-cellular structure, soft, of a grayish white color, and not blackened by the pigment. The ciliary arteries and nerves enter this ligament, and are traced through it to the iris. From the nerves which Soemmering saw it contain, he considered it a nervous ganglion. It has also been considered a muscular, tendinous, and glandular structure. A small canal is seen within this ligament, called after its discoverer, the canal of Fontana.

FIG. 99 represents a transverse section of the globe of the Eye seen from within. *a* Cut edge of the three tunics of the eye. *b* Pupil. *c* Iris. *d* Ciliary processes. *e* Front border of the retina.

The *function* of this ligament appears to be purely mechanical.

Ciliary processes, (Fig. 99.)—*Dissection.*—Continue the circular incision made in the sclerotic, through the choroid, and on looking into the anterior half of the divided eye from behind, there is seen a radiated disc of perfectly regular form, surrounding the crystalline lens, which from its resemblance to a radiated flower, is called the *corona ciliaris.* The several rays of this crown constitute the ciliary processes.

These processes are delicate folds of the choroid membrane, extending from the ciliary ligament to the posterior surface of the iris, and forming a ruffle on the forepart of the vitreous humor, around the circumference of the crystalline lens. They are small, triangular in shape, about sixty or seventy in number, according to Zinn, and from a line to two lines in length. Between each pair of these processes, a corresponding one from the hyaloid membrane, extends into and fills up the spaces; thus forming a kind of dove-tailing union, which completes the posterior wall of the aqueous chamber, and prevents the fluid from flowing back in that direction.

The ciliary processes are covered with the pigment. If this be washed off, they are seen to be very vascular, of a grayish color, and continuous with the choroid.

Function.—Various opinions are entertained as to the use of these processes. Some believe them to be muscular, and to have the power of regulating the focal distance of the eye. Others suppose that they consist of a venous erectile structure, and are connected with the motions of the iris. Others, again, say that they secrete the aqueous humor—while others think, with more plausibility, that they secrete or furnish the black pigment with which they are covered, to arrest any superfluous rays which may enter the eye.

Iris, (Fig. 99.)—This organ, so called from the variety of its color, is situated behind the cornea and in front of the lens, and is seen suspended as a perpendicular curtain,

dividing the front of the eye into two chambers, the anterior and posterior. These chambers contain the aqueous humor, in which the iris moves freely. The anterior chamber extends from the cornea to the iris; the posterior from the iris to the lens. The iris is circular in its form in the human eye, and oblong, either transversely or vertically, in many of the inferior animals. It has in its centre an opening called the *pupil*. The size of the pupil varies according to the intensity of the light, the sensibility of the retina, and the distance of the object. When the light is strong, the object near, and the retina sensible, the pupil contracts, while in the opposite condition of things it dilates.

The external circumference of the iris is attached to the ciliary ligament. Its internal circumference forms the margin of the pupil. Its *anterior surface* is flat, and presents the variety of color from which it has been called iris or rainbow. There is stated to be a resemblance between the color of the iris and the hair. In most fish it is found to present a metallic lustre. The *posterior surface* of the iris is covered with a thick layer of dark pigment, and from its resemblance to the ripe purple grape, is called *uvea*.

Structure.—The structure of the iris is regarded as essentially muscular, and has been compared to the columnæ carneæ and chordæ tendineæ of the heart.

On the anterior surface of the iris are seen projecting lines and intervening depressions. Some of these lines surround the pupil after the manner of a sphincter; others radiate from the pupil towards the circumference of the iris, while others are described as interlacing and bifurcating, and ending in small projections. The radiated fibres mingle with the circular somewhat after the manner of the muscles of the mouth, with the orbicularis oris. This arrangement of the muscular fibres satisfactorily explains the *functions* of the iris. When it is required that the pupil shall contract, the sphincter or circular fibres afford the means of doing it, and shutting out the light; when it is necessary to open the pupil, the dilatation is

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effected by the radiating fibres, drawing it apart, while at the same time the circular ones are relaxed.

The posterior surface is deeply stained, as stated, with the black pigment, which is said to be protected by the very delicate membrane of the aqueous humor.

The iris is abundantly supplied with blood vessels and nerves. The arteries come from the long ciliary, which, after entering the sclerotic behind, pass forward between this coat and the choroid, one on either side of the eye, parallel to the *equator oculi*, to the ciliary ligament, here each of them divides, and after forming a circle round the circumference of the iris, sends off radiating branches which converge towards the pupil, and there form anastomotic arches. Some muscular branches of the ophthalmic also supply the iris from the front. The veins are more numerous than the arteries and return the blood either by the ciliary veins, or into the vasa-vorticosa. The nerves of the iris are large, and are supplied by the ciliary nerves, which come from the ophthalmic ganglion. This ganglion is connected with a sentient branch of the ophthalmic, one of the divisions of the fifth, a motive nerve, one of the branches of the third, and with branches of the sympathetic. From this source the ciliary nerves, about 12 or 14 in number, pass through the sclerotic behind, and then go forward on the surface of the choroid to the ciliary ligament, which they enter in great numbers, where they are distributed to the iris. From this bountiful supply of nerves, both of sensation and motion, we can readily understand the great sensibility, and the delicate and rapid movements of the iris.

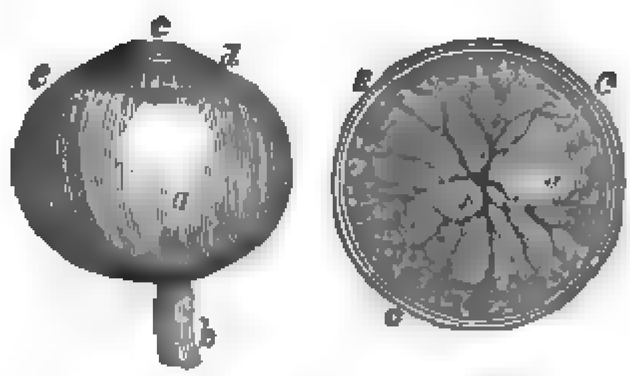
The iris is three or four times thicker than the choroid, and becomes thinner towards the pupillary margin. The pupil is closed the greater part of uterine life, by a delicate membrane, called *membrana pupillaris*. It is represented as most distinct about the fifth month, and as disappearing about the seventh. This membrane separates the anterior and posterior chambers of the eye, and prevents any communication between them till, as just stated, after the

seventh month, when it disappears, and the fibres of both chambers mingle and pass, readily, the one into the other. Cases are mentioned, however, where this membrane has remained after birth, causing blindness. This membrane, according to M. Cloquet, consists of two layers—both serous and formed—the one in front of the iris, lining the anterior chamber, and constituting the anterior layer, and the other, of the one behind the iris, lining the posterior chamber, and forming the posterior layer.

Function.—To act as the diaphragm of the telescope, by its black pigment intercepting all the rays of light except those passing through the pupil.

Retina.—The retina (Fig. 100) forms the third or innermost coat, constituting the membranous case of the eye. It lines the choroid, and is in contact with the vitreous humor. It is the most important of the three membranes, as it is the seat of vision, and is the place where the images of objects are painted.

A FIG. 100. B



Dissection.—The eye being kept under water, carefully remove the choroid, when the retina is distinctly seen.

Structure.—It consists essentially of the expansion of the optic nerve, which forms a middle layer of nervous coat, covered internally by a vascular layer, and externally by a serous one, discovered by Mr. Jacobs. The nervous coat presents a bluish white appearance, is soft, pulpy, easily torn, and extends forward to the ciliary processes. The internal layer, or vascular coat, is compared to the pia-mater, and consists of the minute branchings of the *arteria*

FIG. 100, A represents the Retina after the removal of the Choroid. *a* The Retina. *b* Optic nerve. *c* Iris. *d* Vitreous humor. *e* Where the retina terminates.

FIG. 100, B represents the central artery of the retina. *a* Yellow spot of Soemerring. *b* Point of entrance of optic nerve. *c* Choroid coat. *s* Sclerotic coat.

centralis, the central artery of the retina, which pierces the optic nerve, and then, by its expansion, forms the principal support for the nervous layer. The nervous layer is described by Treviranus, as consisting of cylindrical tubes, or fibres extending, in every direction, from the optic nerve, and terminating in papillæ which are in contact with the hyaloid membrane.

The external or serous layer separates the retina from the pigmentary coat of the choroid, and when suspended in water, is seen as an extremely delicate membrane, which under the microscope presents granules having a tesselated arrangement. On the inner surface of the retina, at the bottom of the eye, where the optic nerve enters, a dark point is seen, called the *porus opticus;* through this the arteria centralis passes, and then divides.

From this point, about a line and a half to the outside, is seen a small, circular spot, having a yellowish border, called the *foramen* of *Soemerring*, or *punctum aureum.* This spot corresponds to the axis of the eyes, and is said not to exist in the fœtus. It is found in man and the quadrumana—that is, in all animals the axes of whose eyes are parallel. It is not seen in the horse, the ox, nor other mammalia, in birds nor in fish. This spot is not a foramen, as supposed by Soemerring, but is found to be covered both by the vascular layer, and the serous layer of Jacobs, there being a depression, and an apparent deficiency of the nervous substance at this point.

Zonula Ciliaris.—This is a term applied to the thin vascular structure connecting the anterior surface of the lens, with the anterior margin of the retina. It is found to present folds, corresponding with, and received between the ciliary processes, arranged in a radiated form, and stained with the pigment around the lens. The membranous case of the ball of the eye thus formed of its three coats, the sclerotic, choroid, and retina, contains four *refractive* bodies, or *media* of light: the *cornea, aqueous humor, crystalline lens*, and *vitreous humor.*

Cornea, (*corneus*, horny,) Fig. 98.—This structure occu-

pies the anterior fifth of the globe of the eye, and is connected with the sclerotica at the ciliary ligament, by a very firm union. The cornea stands out prominent from the sclerotic, somewhat after the manner of the crystal of a watch. It is a perfectly transparent body, highly polished, convex on its anterior surface, and concave on its posterior; thus presenting a lens of the *concavo-convex form*. Its *shape* is spherical, and represents the segment of a smaller sphere placed on that of a larger. Its transverse diameter exceeds the vertical by about one line, which is found to be owing to the overlapping of the sclerotic upon its superior and inferior border. Its density is slightly greater in the centre than at the circumference. Its *structure* is complex and consists of a variety of different tissues, as the *tunica conjunctiva*, the *cornea proper*, *cornea elastica*, and the *lining membrane* of the anterior chamber.

The *tunica conjunctiva* is a fine layer, so closely adhering to the cornea as to have its existence denied by some anatomists, though prolonged maceration has satisfactorily proven its presence, and its continuity with that covering the sclerotic. It is found to be very sensitive, and to consist of cells, of which the superficial are flat, while the deeper are round, and contain a transparent fluid which, soon after death, becomes opaque and white, forming that peculiar film seen then upon the eye.

The *cornea proper* is composed of transparent lamina, which may be few or many, according to the pleasure of the dissector, and which are connected together by the most delicate cellular tissue containing, it is said, a small quantity of fluid by which these lamina are kept in their proper relations with each other.

These lamina can, by a slight rubbing between the fingers, be made readily to glide the one upon the other. Their transparency is destroyed by boiling, and they become permanently opaque; deposition of lymph among the layers, from inflammation, produces the same result, causing what is called, *opacity* of the eye. The several layers of the cornea proper, though somewhat resembling cartilage,

are supposed to be a peculiar modification of fibro-cellular tissue.

The *cornea elastica* is posterior to the cornea proper, and is characterized by the very singular fact that its transparency is not in the least effected by any of the agencies which destroy that of the true cornea. It is a strong, though thin, elastic cartilaginous layer, in close connection with the cornea. Its *function* is to support and preserve the proper curvature of the cornea.

The *lining membrane* of the anterior aqueous chamber forms the fourth and last layer of the cornea. It is of such extreme delicacy, that its existence is rather inferred than proved by dissection.

The cornea, in its healthy state, has no red vessels, though when inflamed, is highly vascular, and though no nerves have been satisfactorily traced into it, its surface is quite sensible. Thus constituted, the cornea presents the most perfectly transparent lens, and is the first of the media through which the light has to pass before reaching the retina. From its great convexity and density, it powerfully refracts and converges the light in its passage through it.

Aqueous humor.—This forms the second refracting medium in order, and is immediately behind the cornea, occupying the cavity between this latter and the crystalline lens. It consists of a perfectly transparent and colorless fluid, secreted by the lining membrane of this cavity. It is called aqueous from its resemblance to water, its specific gravity differing very little from that liquid. Analysis makes it to consist, in 100 parts, of water 98, and the remaining two parts, of chloride of sodium and albumen.

The aqueous humor fills both the anterior and posterior chambers of the eye, having free and easy communication through the pupil.

This humor being fluid, and consequently less dense than the cornea, will not, according to the laws of the refraction of light, so strongly converge the rays in their passage through it, but on the contrary, cause them rather to

diverge from the axis of vision. The light on leaving this fluid falls on the next medium, i. e. the *crystalline lens*, (Fig. 98.)

The *lens* is a beautiful double convex body, situated in a depression in front of the vitreous humor, and behind the pupil. It is more convex posteriorly than in front, and has its axis on a line with that of the pupil.

Its *form* varies: in the fœtus it is more spherical; in the adult the anterior and posterior convexities are greater, while in old age these again diminish. This variation of form is also seen in different individuals of the same age, accounting for the different powers of vision in each. For example, when the convexity of the lens is excessive, the rays of light will be refracted too powerfully, and be brought to a focus too soon, and in front of the retina, producing that kind of defect of vision called *myopia*, or short sightedness. The reverse of this occurs in old people, when the lens is too flat, giving rise to that defect of sight called *presbyopia* or far-sightedness. In this case the focus is thrown behind the retina. The *color* of the lens varies as much as its form. It has rather a pinkish tint in the fœtus, is perfectly clear in the adult, and of an amber color in the old. Its *density* also varies, being much greater in the centre than on the surface. The centre is firm and has been compared to gum-arabic, and called the nucleus. From this point to the surface, it becomes less and less dense, so that the surface is semi-fluid, though every part of the lens has greater density than either of the other humors. Berzelius gives the following analysis: water 58, peculiar matter* 35.9, hydro-chlorates, lactates, and animal

* The *peculiar matter* alluded to in Berzelius's analysis has since been shown to be *globulin*, a substance which is also found in conjunction with *hæmatin*, for the blood corpuscles. It is probably secreted by the lens from the blood furnished it by the *capsular artery*, but how this substance is so perfectly separated from the hæmatin, which every where else accompanies it, remains a profound mystery.

It exists not in the tissue of the lens, but is contained in the form of a very concentrated solution in the cells of that organ. The object of it is, of course, still further to correct *chromatic aberration*, by adding another highly refractive

matter soluble in water 1.3, insoluble membranous matter 2.4. The lens is stated to contain both gelatine and albumen, but no traces of fibrin have been detected. By burning it to ashes, traces of iron are found.

The *structure* of the lens is not satisfactorily settled. All are agreed that it consists of concentric layers, which are easily demonstrated and rendered very distinct by boiling or immersion in a dilute acid. In this manner the layers are seen to be placed one above the other, like the several strata of an onion, and increasing in density as they approach the centre. These lamina seem to be composed of fibres, extremely thin, and under the microscope present a series of fine teeth united together and interlocking with each other. The lens separates readily into three or four triangular fragments, having their bases at the circumference, and their apices at the centre. It is surrounded by a membrane called the *capsule* of the lens. This capsule is elastic, dense, and very transparent, and like the posterior layer of the cornea, boiling and immersion in alcohol do not render it opaque like the lens, and when separated, after being subjected to this operation, its transparency is found to be still preserved.

The use of this capsule seems evidently designed to preserve the form of the lens. It is described as containing a small quantity of fluid, called the *liquor-morgagni*, which by some is thought to be rather the result of a cadaveric change. Around the circumference of the lens there is seen a triangular canal called the *canal of Petit*, which is believed to be formed by the splitting of the lamina of the hyaloid membrane at the lens, one layer going in front of the lens, the other behind, and leaving between the points of separation the above triangular canal. Both the lens

medium to the many already described as traversed by light. It is very interesting to observe, moreover, that nature has not confined herself to an anatomical arrangement in order to obtain a perfect chromatic instrument, but has also resorted, in this instance, to purely physical methods. She has greatly increased the density of this solution towards the centre of the lens, and has accomplished this by a very gradual change, so that this one fluid presents of itself a variety of media for the light to traverse.

and its capsule are frequently the seat of a morbid opacity called cataract. Hence we have the *lenticular* and *capsular cataracts*, which destroy the transparency of the lens or of its capsule, prevent the rays of light from passing to the retina, and consequently produce blindness.

The vitreous humor (Fig. 98) forms the last of the refracting media. It is also called the *hyaloid body*, (ὕαλος, glass,) from its resemblance to melted glass. It occupies the posterior three-fourths of the globe of the eye. Is a perfectly transparent body, spheroidal in its shape, except in its anterior portion, where there is a depression for the reception of the lens, and lies in contact with the whole inner surface of the retina, which is expanded over it.

This humor is of a gelatinous or semi-fluid consistence, holding a medium refractive power between the lens and aqueous humor. It consists of a very delicate, transparent membrane, called the *hyaloid* membrane, and a fluid substance not unlike water.

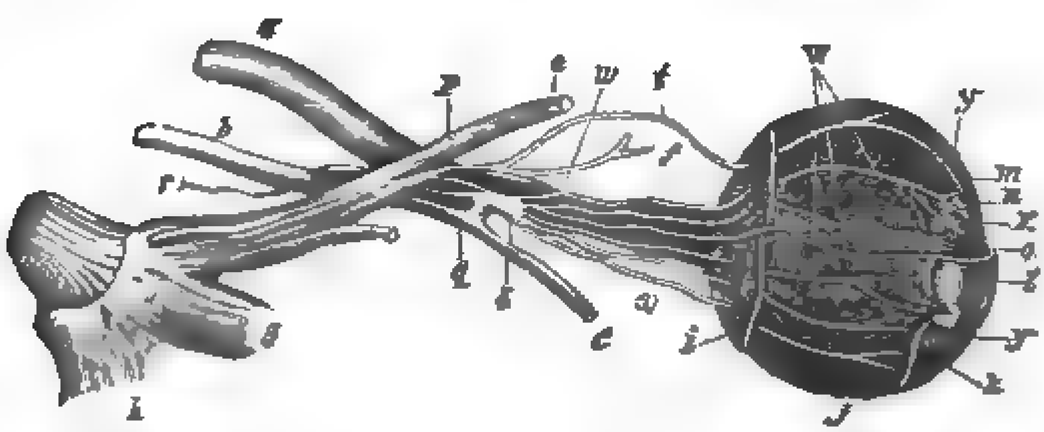
This membrane, besides enclosing the vitreous humor, sends into its interior numerous processes, which, interlacing and uniting, form a very fine cellular tissue, containing the humor in its various cells—thus differing from the aqueous which is received in a single capsule. It has sufficient strength to support the humor when suspended, and on being punctured, the fluid is seen to escape drop by drop, till the whole is discharged. If inflated and dried, or immersed in alcohol, the interior septa and cellular arrangement will become still more evident.

The vitreous fluid, chemically, is found to differ very little from the aqueous, being formed principally of water, and about two per cent. of animal and saline matter. The vitreous humor is supplied with blood by a small artery from the arteria centralis, which is seen to take a "tortuous" course from behind, and lose itself on the capsule of the lens. This vessel, it is supposed, also supplies the hyaloid membrane. The vascular layer of the retina likewise sends vessels into the vitreous humor as well as the ciliary processes in front.

SUMMARY OF BLOOD VESSELS AND NERVES OF THE BALL OF THE EYE.

The *ophthalmic artery* sends off the ciliary branches which are divided into the *short* and *long*. The short are from 10 to 20 in number, they surround the optic nerve, penetrate the sclerotic coat behind, and are distributed upon the choroid, some of the branches going as far forward as the iris and ciliary processes. The long ciliary are two in number, one on either side of the eye, which pass to the ciliary ligament and iris, while the arteria centralis, penetrating the optic nerve and passing through its centre, supplies the retina, vitreous humor, and crystalline lens.

FIG. 101.



The nerves of the eye-ball (Fig. 101) come from the ophthalmic ganglion. This ganglion, called also *lenticular* and *ciliary*, is situated in the posterior part of the orbit, between the rectus externus muscle, and optic nerve. It is imbedded in adipose structure, and presents a reddish aspect. It is described as having four angles, the posterior superior

FIG. 101 represents the Nerves of the Eye-ball. *a* Optic nerve. *b* Trunk of the motor oculi. *c* Inferior branch of this latter nerve. *d* Ganglion of Gasser. *e* Ophthalmic or first branch of the fifth. *f* Nasal branch of the ophthalmic. *g* Superior maxillary or second division of the fifth. *h* Inferior maxillary or third division of the fifth. *i* Posterior coat of the sclerotica, where the ciliary nerves enter. *j* Choroid coat. *k* Front portion of the sclerotica. *l* Lower segment of the cornea. *m* Ciliary ligament. *n* Iris. *o* Pupil. *p* Sensitive root of the ophthalmic ganglion. *q* Corresponding motor branch of this sensitive root. *r* Sympathetic filament. *s* Ophthalmic ganglion. *t* Long ciliary nerves. *u* Anastomosis between the short ciliary nerve and nasal branch. *v* Ciliary nerves from ophthalmic ganglion. *w* Ciliary nerves anastomosing with each other. *x* Motor branches of the same nerves *y* Ciliary nerves that penetrate the sclerotica, and supply the conjunctiva.

receiving a filament from the nasal branch of the ophthalmic, and the posterior inferior a motor branch from the third pair; while from the anterior angles proceed the ciliary nerves. These are from ten to twenty in number, accompany the ciliary arteries through the sclerotic coat, surround the optic nerve and proceed forward to the ciliary ligament between the sclerotic and choroid, and terminating, as before described, upon the iris. Filaments of the sympathetic also go to this ganglion. The ophthalmic ganglion is thus seen to embody nerves both of motion and sensation, the former coming from the third, the latter from the fifth, besides having sympathetic branches.

The eye proper, or the ball, is thus seen to be a very complex organ—consisting of a great variety of parts, at once most delicate and beautiful in their structure, as well as most surprising and admirable in their nice adaptations to each other and to light.

It may now be proper to make a remark or two on the whole collectively, in their conjoint action, and harmonious co-operation in enabling us to see.

Light, in coming from any object, falls first upon the cornea, which being a convex lens on its anterior surface, and more dense than the air, refracts the light and causes it to converge towards a focus; after leaving the cornea it passes through the aqueous humor, a medium less dense, consequently having less refraction, and producing rather a divergence or bending of the rays from the perpendicular; on leaving the aqueous fluid the rays pass next in order through the crystalline lens, and here, from the double convexity and density of this body, they undergo a powerful convergence or bending to a focus—to obviate which, before reaching the retina they are made to pass through another medium, the vitreous humor, which is neither so convex nor so dense, and are thus brought to the proper focal distance by the time they reach the retina or seeing membrane of the eye.

The rays of light in passing through the lenses of the telescope would be liable to confusion, and the production

of very indistinct images, were it not for the diaphragm and the black lining of this optical instrument. These imperfect images are termed *aberrations* of light, and are reduced to three, i. e., the aberration from *sphericity*, from *parallax*, and *chromatic aberration*. Now nature has provided in the living eye contrivances much more perfect, in obviating these several varieties, than any to be found in the workmanship of man. These consist of the iris, the ciliary processes, the choroid membrane, and the lenses of different refracting power. The aberration of sphericity is corrected by the iris, whose black pigment intercepts all the lateral rays which fall upon the cornea, and allows only those to enter which are in the axis of vision. Were it not for this provision, all the rays falling on any portion of the cornea, not in a line with the pupil, would converge sooner and form different focal points, and necessarily produce indistinct vision.

Aberration from parallax, as it is termed, is caused by the rays of light coming from distant objects in parallel lines, and being consequently brought to a focus soon, and near the lens, while the rays from near objects are divergent and do not come to a focus for a much greater distance; for the law is, the further the object the nearer the focus to the lens; the focal distance behind the lens corresponds to the distance of any object. The eye, it is known, has the power of accommodating itself to, and seeing at, different distances—but in what this power consists (and where it resides) is not exactly agreed. Some suppose the *lens* to be muscular, and thereby capable of altering its form, density and distance from the retina, and thus always producing the proper focus at any distance at all within the range of vision. By others the *muscles*, acting upon and compressing the globe of the eye, and thus changing its form, are supposed to furnish this power. Others again assign the cause to a change in the convexity of the cornea.

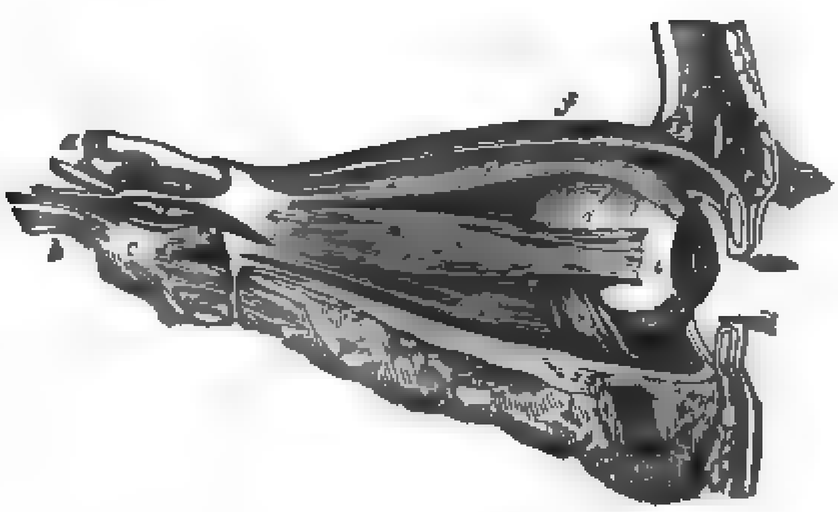
Chromatic aberration, or the confusion in sight arising from the decomposition of the light in its passing through

the lenses, and producing a variety of colors, as seen in the solar spectrum, is corrected in the living eye by the presence of different media, each having different density and different refracting power, thus balancing each other, and thereby preventing any confusion arising from color.

APPENDAGES OF THE EYE.

The *Appendages of the Eye* (*tutamina oculi*) consist of the *Muscles*, *Eyebrows*, *Eyelids*, and *Lachrymal Apparatus*.

FIG. 102.



The *Muscles* belong to the globe of the eye, the upper eyelids and the tarsal cartilages. To the globe belong six muscles, four straight and two oblique. The straight, called *recti*, consist of the *superior*, *inferior*, *external* and *internal recti*.

Dissection.—The *rectus superior*, or *levator oculi*, situated beneath the upper eyelid and the *levator palpebrarum* muscle, is exposed by removing the roof of the orbit, which is done by sawing the frontal bone at the outer and inner extremities of its orbitar edge, when with a few blows by the hammer upon the superciliary portion, it can be removed. The brain is supposed to have been first taken away.

This muscle *arises* from the superior margin of the optic foramen small and tendinous, also from the fibrous sheath of the optic nerve. It passes forward over this nerve and the superior portion of the ball, and is *inserted* into the sclerotic by small tendinous fibres near the cornea.

FIG. 102 represents the Muscles of the Eye-ball. *a* Optic nerve. *b* Trigeminus or fifth pair of nerves. *c* Ganglion of the fifth pair or of Gasser. *d* Superior oblique muscle. *e* Rectus superior. *f* Rectus externus. *g* Rectus inferior. *h* Obliquus Inferior. *i* Ball of eye. *j* Levator palpebrarum.

Function.—To raise the eye. It covers the third, nasal, and optic nerves, with the ophthalmic artery.

Rectus inferior (or *depressor oculi,*) situated on the inferior margin of the optic foramen by a ligament common to this muscle, and the external and internal rectus, called the *ligament* of *Zinn,* and from the fibrous sheath of the optic nerve, passes forward beneath the optic nerve, and upon the floor of the orbit, separated from it by the inferior oblique muscle and some adipose matter, and terminates in a tendon which is inserted into the under surface of the sclerotica, near the cornea.

Function.—To depress the eye.

The *Rectus externus,* (or *abductor oculi,*) situated on the outer portion of the orbit, is the longest of the recti muscles. It *arises* by two heads, one from the external margin of the optic foramen and optic sheath, the other from the ligament of Zinn. The muscle passes forward, ends in a tendon which is *inserted* into the outer surface of the sclerotica near the cornea; between the two heads of this muscle, the third, nasal, and sixth nerves pass, the latter nerve being wholly spent upon this muscle. It is separated from the optic nerve and the ball of the eye, by the lenticular ganglion, ciliary vessels, nerves, and fascia.

Function.—To abduct or roll the eye outward.

The *Rectus internus,* (or *adductor oculi,*) situated upon the inner portion of the orbit, *arises* from the inner margin of the optic foramen by the ligament of Zinn, and from the optic sheath—it passes forward, becomes tendinous, and is *inserted* into the inner surface of the sclerotica near the cornea.

Function.—To roll the eye inward.

The *obliquus superior,* (or *trochleator,*) situated at the upper and inner part of the orbit, is a long and slender muscle, *arising* by a small tendon from the inner margin of the optic foramen, and from the sheath of the optic nerve; it proceeds forward and upward, along the os-planum to the internal angular process of the frontal bone, beneath and rather behind which, this muscle forms a round tendon

which passes through a cartilaginous pully at this place, and is then reflected backward beneath the superior rectus, to be *inserted* into the outer part of the sclerotica, about half way between the cornea and entrance of the optic nerve. The fourth nerve occupies its upper surface, the nasal nerve and ophthalmic artery are on its lower surface.

The pully of this muscle is attached by a movable ligament to the bone, and is lined by synovial membrane, which admits of free play.

Function.—To roll the eye obliquely downward and outward.

Obliquus inferior, situated at the anterior and inferior part of the orbit, is a thin and flat muscle, and *arises* from the orbital plate of the superior maxillary bone, above the infra-orbital foramen, and outside of the lachrymal groove: it passes obliquely outward and backward, beneath the inferior rectus, and is inserted into the outer and posterior part of the sclerotic.

Function.—To roll the eye downward and inward.

Levator palpebræ superioris, situated along the roof of the orbit, is a long, flat, and triangular muscle, *arising* from the superior margin of the optic foramen, by tendinous fibres, and passes foward to be *inserted* into the upper border of the superior tarsal cartilage.

Function.—To raise the upper eyelid. The lower surface of this muscle has a branch of the third nerve supplying it; while the frontal branch of the ophthalmic is upon the upper surface

Tensor tarsi, a small muscle situated at the inner canthus of the eye, and discovered by Dr. Horner. It *arises* from the "posterior superior part of the os-unguis, and advancing three lines, it bifurcates—one bifurcation is *inserted* along the upper lachrymal duct, and terminates at its junction, or near it;" the other has the same insertion upon the lower lachrymal duct. The caruncula lachrymalis is in the angle of the bifurcation. At the inner canthus this muscle is connected to the orbicularis palpe-

brarum, and its nasal portion is described as adhering closely to the lachrymal sac.

Function.—According to Horner, it dilates the lachrymal sac, thus producing a vacuum by which, through atmospheric pressure, the tears are constantly propelled into it. Another use is also assigned it, i. e., of keeping the eyelids in contact with the ball.

Fascia of Muscles.—The muscles of the orbit are surrounded by a distinct fascia, called the *ocular fascia*, which separates them from the ball of the eye. It is loose upon the ball, and represented by Mr. Ferrall as having six openings for the passage of the tendons of the several muscles, which play through it as so many pulleys. Its use is supposed to be to protect the ball of the eye from the action of the muscles, and to connect and retain all these muscles in their proper relations.

Combined action of Muscles.—When the recti muscles act in pairs, the eye is rolled in the diagonal of their action, as upward and inward, downward and inward, upward and outward, downward and outward. The two oblique, acting conjointly, draw the eye forward.

THE NERVES OF THE MUSCLES OF THE EYE. (Fig. 101.)

These comprise the third, fourth, and sixth, which are motor nerves, with the first or ophthalmic division of the fifth, which is a nerve of sensation.

These nerves, entering the orbit through the foramen lacerum superius, as described under the head of cerebral nerves, are distributed as follows: The *third pair*, or *motores oculorum*, divides into a superior and inferior branch. The superior is the smaller of the two, and, going between the two heads of the rectus externus muscle, over the optic and nasal nerves, is distributed to the *rectus superior*, and *levator palpebræ* muscle. The inferior or larger branch passes to the outside and below the optic nerve, then separating into three branches, is distributed to the inferior rectus, the rectus internus, and inferior oblique muscle.

The branch to this latter muscle sends a twig to the ophthalmic ganglion.

The fourth pair (*nervi pathetici or trochleares*, Fig. 16,) proceed above the superior rectus and levator palpebræ, obliquely inward and forward, and go to supply the superior oblique muscle.

The sixth pair, (*motores externi or abducentes*,) after passing between the two heads of the rectus externus, proceed outward and forward, and are distributed solely on the ocular surface of this same muscle.

The fifth pair, (*nervi trigemini*,) *the ophthalmic division*, (Fig. 74,) is the smallest. It proceeds from the superior angle of the Gasserian ganglion, about an inch in length, runs through the cavernous sinus, and here passes above the sixth and below the third and fourth nerves, receiving in this sinus some filaments from the sympathetic. It has a sheath of dura-mater, and on reaching the orbit divides into three branches, 1. The *lachrymal;* 2. The *frontal;* 3. The *nasal.*

The *lachrymal* proceeds outward and forward above the rectus externus to the lachrymal gland, and is the smallest of the three branches. It accompanies the lachrymal artery, and as it approaches the gland it divides into two filaments, one of which passes through the malar bone and connects with the facial nerve; the other passes through the spheno-maxillary fissure and connects with the superior maxillary nerve. Its terminating branches are spent upon the lachrymal gland, tunica conjunctiva and upper eyelid.

The *frontal* branch is the largest of the three, and proceeds forward above the muscles of the orbit, between them and the periosteum, and on approaching the superior orbitary margin divides into an internal and external branch. The *internal* or *supra-trochlear nerve* passes above the trochlea of the superior oblique muscle, connects with the nasal nerve, and is distributed, after passing over the inner margin of the orbit, to the corrugator supercilii, occipito-frontalis and orbicularis palpebrarum muscles.

The external or proper frontal branch, called also *supra-orbital,* ascends on the forehead through the supra-orbital notch or foramen, and divides into numerous filaments supplying the muscles and scalp in this region, and communicating with its fellow of the opposite side and with the facial and occipital nerves.

The *nasal* branch separates from the ophthalmic in the cavernous sinus, and entering the orbit between the two heads of the external rectus, proceeds inward and forward along the inner surface of the orbit, below the superior oblique muscle, to the anterior æthmoidal foramen, through which it passes into the cranium upon the cribriform plate of the æthmoid bone, and then descends through this plate by the side of the crista galli, into the nose, where it is distributed upon the septum and posterior surface of the nasal bones, as far as the tip of the nose.

The nasal nerve gives off, in its course, a branch which goes on the outer side of the optic nerve, to the ophthalmic ganglion; also two other branches, termed ciliary nerves, which do not connect with the ganglion, but go directly into the ball of the eye, through the sclerotica, along with the rest of the ciliary nerves. It also sends off the *infra trochlear* branch, which passes below the pulley of the superior oblique, supplying the lachrymal ducts, sac, and caruncula lachrymalis—communicates with the superior trochlear nerve, and is finally distributed to the side and dorsum of the nose.

The *Function* of all these branches of the ophthalmic, is to give common sensibility, or general feeling to all the parts to which they are distributed.

The *superior* and *inferior maxillary* nerves, forming the second and third divisions of the fifth, will be found described under the head of nerves of the passive and active organs of mastication, which see. The arteries supplying the muscles come from the ophthalmic.

The eyebrows (*supercilia*) form the upper boundary of the orbit, and consist of a quantity of sub-cutaneous cellular and adipose structure, with the corrugatores supercilii

muscles, and muscular fibres of the occipito-frontales and orbiculares palpebrarum. The hairs are arranged in two rows, the superior inclining downward and outward, the inferior upward and outward. Both rows converge in the middle, so as to cause a fullness and regular prominence.

The *function* of the eye-brow is to shade the eye from too strong light, and to shield it from particles of dust, and from the perspiration.

The eyebrow can be elevated by the occipito frontalis, depressed by the orbicularis palpebrarum, and drawn towards the nose by the corrugator supercilii.

Blood-vessels of the eyebrows.—The arteries come from the ophthalmic and temporal. The veins have corresponding names with the arteries and discharge into the cavernous sinus.

Nerves of the eyebrows.—These come from the ophthalmic branch of the fifth pair and the facial.

The eyelids (*palpebræ*) form two movable curtains, situated in front of the eye, and adapted to protect this organ from injury. The eyelid in man consists of two portions, a *superior* and an *inferior* lid; while in some animals there is a third. When the lids are open, the points of connection at their inner and outer extremities are called *canthi*, *angles*, or *commissures*.

The internal canthus presents a triangular space called the *lacus lachrymalis*, which encloses a little body, the *caruncula lachrymalis*. On the free margin of each lid, at the inner extremity, and a little to the outside of the caruncle, is seen an eminence called the lachrymal *papilla* or *tubercle*. In each of these papillæ, at the apex, is seen a small opening, the *punctum lachrymale*, which is the commencement of the lachrymal canals, conducting the tears to the lachrymal sac.

The *structure* of each eyelid consists of the integument, muscle, tarsal cartilage, tunica conjunctiva and Meibomian glands.

The *integument* is thin, delicate, loose, and remarkable for the entire absence of fat, which would, in this situation,

be extremely inconvenient. The muscle, called orbicularis palpebrarum, has been already described as a broad, elliptical sheet of pale semi-circular fibres, covering each tarsus and connected at each canthus, by whose action the lids are closed.

The *tarsal cartilages* are thin, elastic plates of fibro cartilage, which support and preserve the form of the eyelids. The one belonging to the upper lid is semi-lunar, broad in the middle and tapering at either extremity. It lies between the orbiculari and levator palpebræ muscles. Its lower border or free margin is thick. Its upper or orbital edge is thin, for the attachment of the levator palpebræ and *broad ligament* of the tarsus, which fixes the cartilage to the base of the orbit. This fibrous ligament is continuous with the periosteum at the base of the orbit. It is thicker at the outer than at the inner portion of the lid. It attaches the extremity of this lid to the outer canthus, and extends to the lower lid, which it supports and connects in a similar manner; at the inner canthus the tendo oculi serves to fix the tarsi at this point. The tarsal cartilage of the lower lid is much narrower than that of the superior. The free margins of both lids are furnished with strong, stiff, and curved hairs, arranged in triple, sometimes quadruple rows, and called *ciliæ*. Those of the upper lid are longer and stronger than the lower, and curve upward. Those in the lower curve downward, so that when the lids are closed, they cannot interfere with each other, as they only touch at their convexities. The eye-lashes, thus arranged, serve to shade the eye from the intensity of light, and to guard it from particles of dust and foreign bodies.

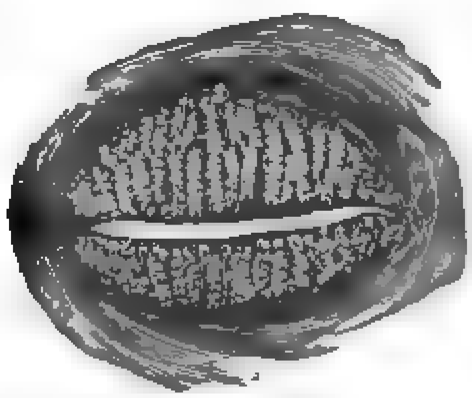
The tunica conjunctiva forms the mucous membrane of the lids and eye. It is situated on the posterior surface of the tarsal cartilages which it lines, and is then reflected upon the ball of the eye, forming at the angle of this reflection in the upper lid, the *superior palpebral sinus*, and in the lower the *inferior palpebral sinus*. On the eye it covers about the anterior third, being connected by cellular tissue, which is loose till it reaches the cornea. It is traced

over the cornea with difficulty, so much so that its existence here is denied by some. From the lids it is continuous with the skin in one direction, and in another lining the Meibomian follicles, excretory ducts of the lachrymal gland, and puncta lachrymalia. At the inner canthus of the eye it forms a semi-lunar fold, called *plica semilunaris*, which represents the *membrana nictitans* of quadrupeds, or the third eyelid of birds. This fold has a thin fibro-cartilaginous plate, and is very vascular.

Caruncula lachrymalis.—This is a small projection of a bright red color in health, but pale and flaccid in disease, situated at the inner canthus, between the lachrymal ducts and within the lacus lachrymalis. Its *structure* consists of an assemblage of minute follicles surrounded by a dense fibro-cartilaginous tissue; it furnishes the whitish secretion so often seen at the inner canthus.

Meibomian glands, (Fig. 103.)—These are situated on the posterior surface of the lids, covered by the tunica conjunctiva, and imbedded in grooves of the tarsal cartilages. They are seen as strings of long parallel ducts, of a pale yellow—about thirty in number to the upper lid, and not quite so many to the lower, opening on the margin of each lid, by a row of minute orifices, behind the cilia. These are visible with a lens. Each Meibomian gland is simply an inflection of the mucous membrane, forming a follicle which is extended into a long and tortuous tube, having a cœcal termination surrounded by numerous small and clustered follicles which open into it, and constitute so many offsets, or cœcal diverticula.

FIG. 103.



Function.—To secrete an unctuous fluid which lubricates the margins of the lids, and prevents their adhesion, which

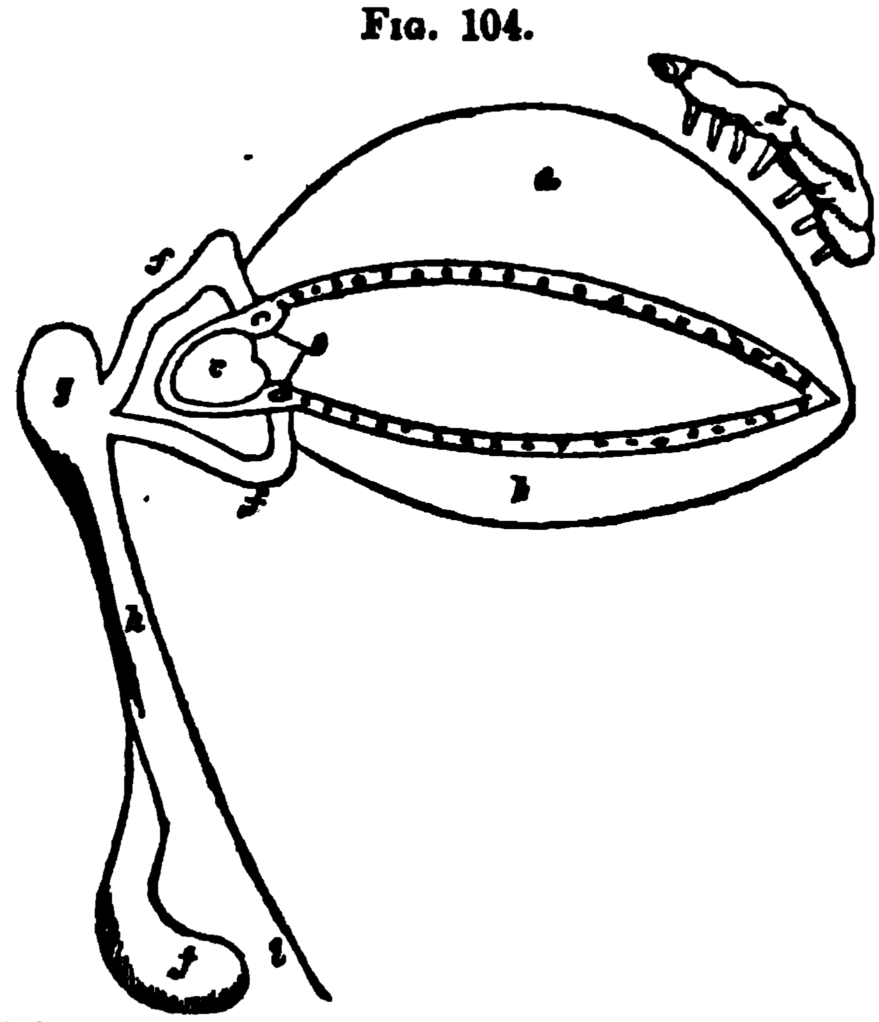
FIG. 103 represents the Meibomian glands. 1 Meibomian glands as seen on the inner side of the lids. 2 Entrance to puncta lachrymalis. 3 Caruncula lachrymalis.

sometimes occurs when this secretion becomes glutinous from disease.

Blood-vessels.—The eyelids are supplied with arteries by the palpebral branches from the ophthalmic, internally, and by the facial, transverse facial, and infra orbital, externally and inferiorly. The *nerves* come from the fifth and the facial.

Lachrymal Apparatus.—This apparatus (Fig. 104) consists of a variety of parts—*first*, of a *gland* to secrete the tears; *second*, *tubes* to carry the tears to the eye; *third*, *puncta lachrymalia* and *lachrymal ducts*, to carry this fluid from the eye into *fourth*, the *lachrymal* sac, whence it reaches the nose by *fifth*, the *nasal duct*. The *lachrymal* belongs to the conglomerate division of glands, and is *situated* at the upper and outer angle of the orbit, occupying the lachrymal fossa in the orbital plate of the frontal bone.

FIG. 104.



This gland is of a pale reddish color, consisting of two lobes, a superior or orbital, and an inferior or palpebral, having a covering of cellular structure. The orbital is the larger portion, being about three quarters of an inch in length, and half an inch in breadth. Its upper portion is convex, and in relation with the periosteum of the orbit; its lower is concave, and in relation with the superior and

FIG. 104 represents the Lachrymal Apparatus. *a* Tarsal cartilage of the upper lid. *b* Tarsal cartilage of the lower lid, and the opening along the margins are those of the Meibomian glands. *c* Caruncula lachrymalis. *d* Lachrymal gland. *e* Puncta lachrymalia. *ff* Lachrymal ducts. *g* Lachrymal sac. *h* Nasal duct. *i* Where it terminates in the inferior meatus of the nose. *j* Inferior turbinated bone.

external rectus muscle. The palpebral portion is smaller, has a more dense capsule, and is only partially separated from the orbital. It extends down as far as the orbital edge of the cartilage of the upper lid.

The tears, secreted by this gland, are conveyed away by from six to twelve excretory ducts which pass, for a short distance and nearly parallel beneath the conjunctiva, to the upper margin of the tarsal cartilage, where they open by separate orifices, in a curved line on the inner surface of the upper lid.

Function.—To secrete the tears which moisten the eyelids and the eye. The tears consist, chemically, of water, and about one per cent. of muriate of soda, and a yellow extractive matter.

Puncta Lachrymalia, (Fig. 104.)—These are two small orifices, situated upon the papillary eminence, seen at the inner extremity of each ciliary margin. They are always open, and form the commencement of the *lachrymal canals,* which are one to each eyelid, proceeding from the puncta. The superior is longer and more curved; it first ascends, and then bends suddenly downward and inward to the sac, entering at its anterior and orbital portion. The inferior canal, at first, descends, and then turns abruptly inward and a little upward, entering the sac at nearly the same point with the upper canal. These canals consist of dense and elastic structure, lined by mucous membrane, and have the *tensor tarsi* muscle inserted into them.

The lachrymal sac, (Fig. 104,) is situated in the groove of the os unguis, bounded in front by the nasal process of the superior maxillary bone. It consists of mucous membrane, covered by a strong fibrous expansion from the tendo oculi, which tendon crosses it transversely a little above its centre, and is an important point to bear in mind in opening this sac, for fistula lachrymalis. The *tensor tarsi* muscle covers its orbital surface. On opening this sac, its lower portion is found constricted, and continuous with the *nasal duct;* at this point there is sometimes found a semilunar fold or valve, separating the two. The interior of

the sac is of a pale color and soft, and generally found filled with mucus.

The nasal duct is continuous with and leads from the sac, downward, backward, and outward, covered by the lower turbinated bone, and opening into the inferior meatus of the nose below. It is a short canal, about three quarters of an inch in length, a little curved, wider at the centre than at either end, and separated from the antrum by a thin, but strong bony partition.

Its *structure* is fibro-mucous; the mucous membrane continued from the sac and lining its interior.

Blood-vessels.—The lachrymal gland is supplied by the lachrymal branch of the ophthalmic artery, and the sac by the nasal branch of the same artery.

The nerves come from the lachrymal branch of the ophthalmic and orbital branch of the superior maxillary.

Blood vessels and Nerves of the Eye and its Appendages.—These have been described in the examination of the several parts composing the organ of vision, and we only propose making a single remark by way of refreshing the memory, as applicable to the whole.

The *ophthalmic artery,* from the internal carotid, and the *facial, temporal,* and *infra-orbital* from the external carotid, are the great sources of arterial supply to the apparatus of sight. The nerves come from the *second* or *optic,* the *third* or *motor oculi,* the *fourth* and *sixth* also motor, the *fifth* and *seventh* pair, and from *sympathetic* branches. See Figs. 73, 74 and 101.

SECTION II.

THE EAR.

The *ear,* the *organ* of *hearing,* is next in importance of the external senses, in conveying intelligence to the mind; and is the especial organ adapted to receive the impressions of *sound,* and to transmit those impressions to the sensorium.

Just as we have seen the eye to have special relations with light, and its retina or nervous expansion to be sensible to all

the varied impressions arising from the different varieties of color, and its optic nerve accurately to transmit those impressions to the brain or mind; so in the ear we have an organ having special relation with sound, an auditory nerve, sensible to all the impressions of the varied sonorous vibrations, and a capacity for conducting those impressions to the brain, or common sensorium, where *perception* of their presence occurs, and where the mind forms an estimate of their value. The *ear* is usually divided into three portions, an *external*, *middle*, and *internal* portion.

Fig. 105.

The *external ear,* (called *pinna* or *auricle,*) situated, as is well known, at the side of the head, and between the mastoid and squamous portions of the temporal bone, consists of the pinna and external meatus.

The pinna presents a number of eminences and depressions, forming folds and hollows, constituting a very irregular surface, and all having special names assigned them. The superior folded border is called *helix,* (ἑλιξ, a fold.) The projecting eminence below this is the *anti-helix.* The depression between the two is called the *fossa innominata.* The pointed projection looking backward and overhanging the meatus as a valve, is called the *tragus* (τραγος, a goat,) from having hairs supposed to resemble the goat. Just opposite to this there is another eminence called the *anti-tragus.* The upper extremity of the anti-helix divides into two crura, leaving a triangular space between them, called *scaphoid* or *navicular fossa.*

Fig. 105 represents the external Ear. *a a* Helix. *b b b* Anti-helix. *c* Scapha or fossa navicularis. *d d* Fossa innominata. *e* Tragus. *f* Antitragus. *g* Lobulus. *h* Concha. *i* Meatus auditorius externus.

All the depressions and furrows of the pinna, converge to a large, central, funnel-shaped cavity, the *concha,* which leads obliquely downward and forward to the *meatus auditorius externus.* The soft and pendulous portion of the pinna, at its lowermost part, is named the *lobulus.*

The *structure* of the *pinna* consists of *integument, fibro-cartilage, muscles,* and *ligaments.*

The *integument* is remarkable for its strong adhesion to the cartilage, and for its thinness and transparency. The folding of the skin enclosing fat constitutes the lobule. The skin is supplied with numerous sebaceous follicles, which are most abundant in the concha and scaphoid fossa.

The *fibro-cartilage* gives the shape to the auricle, forms the framework of its support, and is the source of its elasticity and pliability. It presents very nearly the same eminences and depressions as those already described. The lobule is without the cartilage. This cartilage is covered with perichondrium, which becomes weak and brittle on being removed. The tragus is separated from the helix by fibrous tissue, and presents a deep fissure. A considerable fissure separates the termination of the helix and anti-helix from the concha.

The muscles of the external ear consist of those which attach it to the head, and of those passing from one cartilage to the other. The first division comprises three muscles, the *superior* or *attollens aurem,* the *anterior* or *attrahens aurem,* and the *posterior* or *retrahens aurem,* (Fig. 82.)

The *attollens aurem* is a triangular muscle, the largest of the three, and *arises,* broad and tendinous, from the cranial aponeurosis above the ear; it descends, becomes fleshy, and is *inserted* into the upper and anterior part of the concha.

Function.—To raise the external ear, and deepen the meatus.

Anterior auris, also triangular, *arises* from the posterior part of the zygomatic process and cranial aponeurosis, and is *inserted* into the anterior part of the helix.

Function.—To bring the ear forward. This muscle rests upon the temporal vessels, nerves, and fascia.

Posterior auris, arises from the mastoid process by two or three fasciculi, and is inserted into the back part of the concha. *Function.*—To draw the ear backward and enlarge the meatus.

The *proper* or *intrinsic* muscles of the external ear receive their names from the prominences to which they are attached, as the *major helicis, minor helicis, tragicus, anti-tragicus, transversus auriculæ.*

Major helicis is a small band of muscular fibres lying upon the superior border of the helix.

Minor helicis is below the last, and posterior upon the helix, at its commencement in the concha.

The *Tragicus* covers the cartilage of the tragus.

The *Anti-tragicus* reaches from the anti-tragus to the posterior part of anti-helix.

Transversius auriculæ, situated on the posterior surface of the pinna, extends transversely from the concha to the helix. These muscles are very feeble in man, and scarcely to be recognized; but in most quadrupeds they are well developed, and capable of altering, with ease and rapidity, the form and direction of the auricle.

Meatus auditorius externus is a tube extending from the lower part of the concha, inward to the membrana tympani. It is about an inch and a quarter in length, and has its external half cartilaginous—the remainder osseous. Its *direction* is curved, leading first forward and upward, then backward; and by pulling the ear backward and upward, the canal can be straightened, and the membrana tympani seen. The upper and posterior part of the meatus consists of dense fibro-cellular tissue, extending from the concha to the osseous part of the canal. The osseous portion of the meatus in the child is simply a bony ring, and is much shorter. In the adult, it forms the anterior and inferior walls of the meatus externus, and also an investing sheath to the styloid process, being separated from the glenoid cavity, by the fissure of Glasser.

The external opening of the meatus is of oval form; of variable size, and often, in old people, containing coarse hairs, which prevent the entrance of insects and foreign bodies.

The meatus is lined by the skin continued from the auricle—it becomes, however, very thin, vascular, and sensitive, and set with delicate hairs. Beneath it are seen numerous follicles, which appear upon its surface by many orifices, and are called ceruminous glands. These glands are little oval bodies, of a pale yellow, having a tortuous cœcal tube; they secrete the cerumen or wax of the ear.

This secretion is a viscid matter, intensely bitter, at first soft, but soon becoming solid, and designed to defend the meatus from foreign intrusion.

The *ligaments* of the *pinna* are the *anterior*, which connects the tragus and anterior part of the helix to the root of the zygoma; and the *posterior*, connecting the concha to the mastoid process. Some fibres, extending from one eminence to another, are also spoken of as ligaments.

The *Arteries* of the external ear come from the posterior auricular of the external carotid, and the anterior auricular of the temporal.

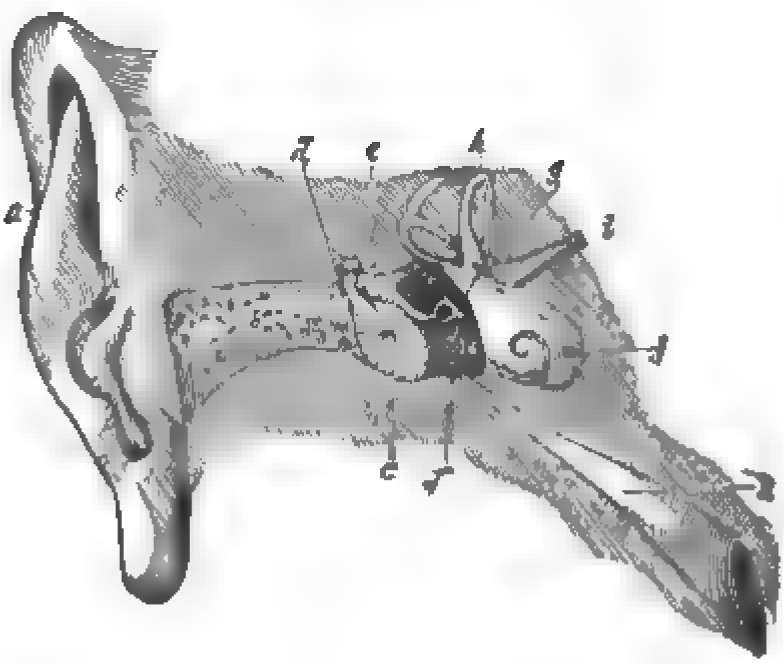
The *Nerves* are supplied by auricular branches from the cervical plexus, and the fifth. At the anti-tragus a branch perforates the meatus, and is distributed upon the inner surface of the concha.

Middle Ear, or Tympanum.—Dissection.—Remove the membrana tympani, or cut away the anterior part of the base of the petrous portion of the temporal bone, and the tympanum will be exposed. The *tympanum* (*tympanum*, a *drum*) is a small cavity of irregular form, *situated* between the meatus externus and the labyrinth or internal ear, having the mastoid portion of the temporal bone behind, and communicating, in front, with the Eustachian tube.

Its external boundary is the *membrana tympani*, or drum of the ear. This membrane, situated at the bottom of the meatus, is of a circular form, and directed obliquely downward and inward, in such way that the inferior wall is

longer than the superior. Its circumference is fitted like a watch-glass into the circular furrow in the base of the meatus, in the adult, and into the tympanic ring of the fœtus. It is a thin, semi-transparent, dry, parchment-like membrane, and consists of three layers, an external or cutaneous, already described, a middle, or fibrous, and an internal or mucous.

FIG. 106.



The middle layer forms the membrane proper of the the drum, and gives the form and strength to this septum between the meatus and tympanum. It is fibrous, and the fibres are seen radiating from the circumference to the centre, where the malleus is attached. Mr. E. Home, from the examination of this membrane in an elephant, was led to regard its structure as muscular, which opinion, however, is not generally adopted. The internal layer is the continuation of the mucous membrane from the pharynx into the Eustachian tube and the cavity of the tympanum. The membrana tympani is capable of injection and presents a beautiful arrangement of radiated and delicate vessels. It is formed for vibrating, and its *function* is to receive the sonorous undulations from the air, and transmit them to the chain of little bones, in the tympanum, connected with it.

The internal boundary of the tympanum presents a bony

FIG. 106 represents the external, middle, and internal Ear. *a* External ear. *b* Meatus auditorius externus. *c* Membrana tympani. *d* Malleus. *e* Incus. *f* Cavity of the tympanum. *g* Stapes. *h* Semi-circular canals. *i* Auditory nerve. *j* Cochlea. *k* Eustachian tube.

projection called the *promontory*, above this projection is the *foramen ovale* or *fenestra ovalis*, below it is the *foramen rotundum* or *fenestra cochleæ*.

The fenestra ovalis is situated directly opposite the membrana tympani, is of an oval shape, and leads into the vestibule. In the living subject it is closed by a membrane to which the base of the stapes is attached. This membrane, like the tympanic, consists also of three layers, the lining of the tympanum, the lining of the vestibule, and its proper and intermediate layer of fibrous tissue.

The *foramen rotundum* leads into the cochlea, and is closed by a similar membrane.

The promontory corresponds to the first turn of the cochlea, and has upon its surface three grooves, which converge into a common canal, opening on the inferior surface of the petrous bone, between the *foramen caroticum* and *foramen lacerum posticum*, containing a branch of the glosso-pharyngeal, called *Jacobson's nerve*.

Posterior to the fenestra ovalis is a *hollow process* called the *pyramid*, containing the small stapedius muscle.

The anterior wall contains the opening of the Eustachian tube. This tube is a very important structure, and is *situated* between the tympanum and the pharynx. It is from an inch and a half to two inches in length, passing from the cavity of the tympanum, forward, downward and inward, to the posterior nares, above the velum palati, above and behind the lower meatus of the nose, and on a level with the inferior turbinated bone, opening on the sides of the pharynx, in a large, trumpet-like orifice, sufficient to admit the end of the little finger.

The *structure* of this tube consists of *bone, cartilage, fibrous* and *mucous tissues*.

The bony portion, about seven lines in length, is situated in the angle between the squamous and petrous bones, and connected with the tympanum. It is attached to the groove between the spinous process of the sphenoid and petrous bones, leading to the root of the internal pterygoid process. Its internal or pharyngeal portion is cartilaginous. The

outer wall is composed partly of cartilage and partly of fibrous tissue, covered by the tensor palati muscle. This tube, where it opens into the pharynx, is thick, and presents a division into two angles, the anterior being connected by fibrous tissue to the root of the internal pterygoid plate; the posterior thick, prominent, and admitting of motion. Its mucous tissue forms the internal lining, and is continuous with that of the pharynx, and also with that of the tympanum.*

Function.—To give passage to the air into the tympanum, and to conduct the secretions from the tympanum to the fauces. Obstructions in this tube, from inflammation and other causes, are frequent sources of deafness. Above the Eustachian tube, and separated by a thin osseous plate, is a canal for the attachment of the tensor tympani muscle.

The *posterior wall*, at its upper part, has an opening leading into the mastoid cells, which, like the tympanum, are found to contain air, and are lined with mucous membrane. Beneath this mastoid orifice is a small opening from the aqueduct of Fallopius, transmitting the chorda tympani nerve.

The superior wall presents a depression for the head of the malleus, and the body and short leg of the incus. It is spongy, and has some small vessels passing through it to the dura mater.

The inferior wall is rough and narrow, formed by the auditory and vaginal processes. It has a small opening which gives exit to the chorda tympani nerve from the cavity of the tympanum.

The tympanum contains a chain of little bones, the

* *Muscles of Eustachian Tube.*—Joseph Toynbee, F. R. S., believes he has demonstrated that the mouth of the Eustachian tube is always closed, except during deglutition; and that the cavity of the tympanum is always "distinct and isolated from the outer air," except in deglutition. The muscles which open this tube, he says, are the tensor and levator palati; and he further states that the *function* of *hearing* is best carried on when the tympanum is closed, entirely upsetting the opinion that the air within the tympanum must communicate with the outer air in the pharynx, that vibration may take place, and hearing be produced.—*Amer. Jour. Medical Science, April No.*, 1853.

ossicula auditus, stretching across its cavity from the membrana tympani to the fenestra ovalis. They are four, the *malleus*, *incus*, *os-orbiculare*, and *stapes*, (Fig. 107.)

The malleus, so called from its resemblance to a hammer, is the first in order behind the membrana tympani, and is connected with it. It consists of a head, neck, handle, a long and short process. The head is situated in the depression on the upper part of the tympanum, and is smooth and round above, and concave below for articulating with the incus. Below the head is the constricted portion called the *neck*—from this the long and short processes arise. The long one called the *processus gracilis* or process of Rau, is a slender thorn-like process, proceeding from the anterior part of the neck. It enters the Glasserian fissure, and gives attachment to the *laxator tympani* muscle, which is thought to be more properly a ligament. The short process is external, and rests against the upper part of the membrana tympani. The handle (manubrium) descends almost vertically from the neck, as low as the centre of the membrana tympani, to the radiating fibres of which it is strongly attached.

Fig. 107.

The incus, (or anvil,) Fig. 107, is posterior to the malleus, and has been, not inaptly, compared to a bicuspid tooth. It consists of a body and two crura. The body receives the head of the malleus, and lies in the depression of the tympanum. The superior or short crus proceeds horizontally backward and is found in the opening of the mastoid cells. The inferior or long crus descends vertically into the cavity of the tympanum, having the *chorda tympani* between it and the handle of the malleus, and terminates in a hook-like process, which has on its extremity a small round tubercle, the os-orbiculare.

The Stapes, (Fig. 107,) so called from its resembling a stirrup-iron, is situated between the fenestra ovalis, and the

Fig. 107 represents the Ossicles or Little Bones of the Ear, separately and of the natural size. *a* Malleus. *b* Incus. *c* Os-orbiculare. *d* Stapes.

os-orbiculare. It consists of a head, neck, base, and two crura. Its head is hollow for receiving the os-orbiculare. The neck gives attachment to the stapedius muscle. The base is a flat, oval-shaped plate, like the foot of the stirrup, and is attached to the membrana vestibuli. The two crura or branches extend between the neck and base.

These little bones are connected together by regular articulations, having synovial membranes, and capsular ligaments; with an additional security of three other ligaments—one going from the head of the malleus, to the superior wall of the tympanum; a second connecting the short process of the incus with the mastoid cells; the third, a circular ligament, surrounding the margin of the fenestra ovalis, and connecting it with the base of the stapes.

Muscles of the Tympanum.—Anatomists are not agreed as to the number of these muscles—some making four, others three, and others two; the discrepancy arising from one or two of these muscles being considered as ligaments. The *membrana tympani* has two muscles—a *tensor* and a *laxator.*

Tensor Tympani (or internal muscle of the malleus) *arises* from the Eustachian tube, the spinous process of the sphenoid bone, and from the petrous portion of the temporal. It has distinct fleshy fibres, which are lodged in the canal above the Eustachian tube, and entering the tympanum at its forepart, are *inserted* into the handle of the malleus below the processus-gracilis. *Function.*—To draw the handle inward, and thus make tense the membrana tympani.

Laxator Tympani (or external muscle of the malleus) *arises* from the spinous process of the sphenoid bone—goes through the glenoid fissure, and is *inserted* into the processus gracilis. *Function.*—To relax the membrana tympani. This muscle is often found to be only a ligament.

Laxator Tympani Minor is also regarded as simply a ligament of fibrous cord, extending from the handle of the malleus, below the short process, to the upper margin of the meatus.

Stapedius.—This little muscle, which has been also

thought to resemble a ligament, *arises* within the hollow of the pyramid, and is *inserted* into the neck of the stapes.

Function.—By pressing the base of the stapes against the fenestra ovalis, and thus drawing the bony chain inward, it has been supposed to act as a tensor upon the membrana tympani.

Lining Membrane of Tympanum.—It has already been stated that this membrane is mucous, and continuous with that of the pharynx and Eustachian tube; but in the tympanum it is much more delicate, and closely united to the periosteum, so as to be considered a fibro-mucous membrane. It covers all the inner walls of the tympanum—is reflected round the muscles, nerves, and bones—lines the tympanic surfaces of the membrana tympani, membrana vestibuli, membrana rotunda, and the space between the crura of the stapes, and is continued into the mastoid cells.

INTERNAL EAR OR LABYRINTH.

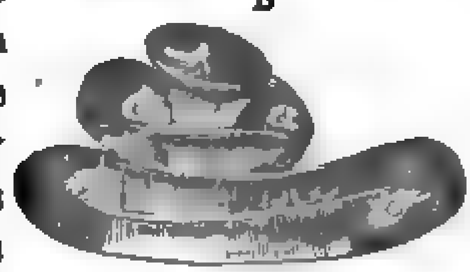
The internal ear or labyrinth, so called from the intricacy of its internal arrangement, is *situated* on the inner side of the tympanum, and deep within the petrous portion of the temporal bone. This is the essential part of the organ of hearing, and consists of the *vestibule, cochlea,* and *semicircular canals.*

The *vestibule* occupies the centre of the labyrinth, being *situated* between the tympanum and meatus auditorius internus, having the cochlea in front, and the semicircular canals behind. It has three dilatations, called *cornua* or *ventricles;* one superior, one anterior, and the third posterior. The superior receives two openings of the semicircular canals, the posterior the other openings of the canals, while the anterior opens into the scala of the cochlea. The inner wall of the vestibule is cribriform and corresponds to the base of the meatus internus, transmitting some fine vessels, and fibrillæ of the auditory nerve. On the posterior wall there is a foramen called the aqueduct of the vestibule, which opens on the posterior surface of the petrous bone, behind the meatus internus.

The *meatus internus* has elsewhere been stated to be situated on the posterior cerebral surface of the petrous bone. It is lined by dura mater, and has a depth of about one quarter of an inch. Its bottom presents a cul de sac or cribriform plate, divided by a bony crest into two portions, the superior has a large opening, the *aqueduct of Fallopius*, for transmitting the facial nerve, and some small foramina which open into the vestibule. The lower portion corresponds to the base of the *cochlea*, and is perforated by many foramina; a part of this inferior depression has apertures also leading into the vestibule. It is through the cribriform base of the meatus internus that the labyrinth is supplied with its nerves and most of its vessels. The anterior corner of the vestibule has a depression called *fovea hemispherica;* and another above this, the *fovea elliptica.*

FIG. 108. A

B



The *Cochlea*, so called from its resemblance to a snail shell, is situated in the anterior part of the petrous bone. Its *form* is conical, its apex being directed forward, while its base corresponds with the bottom of the internal auditory meatus. It consists of a narrowing tube, divided by a partition extending from the base to the apex, into two tubes, and coiled round a central pillar. The tube of the cochlea is described as being about one inch and a half in length, one tenth of an inch in diameter at its base, and

FIG. 108, A represents the Labyrinth of the Ear laid open. *a* Fovea elliptica. *b* Fovea hemispherica. *c* Common entrance of the posterior and superior semi-circular canals. *d* Opening of the aqueduct of the vestibule. *e* Superior semi-circular canal. *f* Posterior. *g* Inferior semi-circular canal. *h* Spiral canal of the cochlea. *i* Opening of the aqueduct of the cochlea. *j* Lamina spiralis.

FIG. 108, B Cochlea laid open. *a* Modiolus. *b* Lamina spiralis. *c* Scala tympani. *d* Scala vestibuli.

about one-twentieth at its summit. It makes a spiral coil of two turns and a half around a central axis or modiolus, and is compared to a winding stair-case. It is separated by a partition, called *lamina spiralis,* into two tubes, named *scalæ,* (scala, a stair-case.) The lamina spiralis consists of an osseous and membranous portion. The osseous forms the inner portion, being in contact with the modiolus, round which it winds. It is broader at the base and gradually diminishes to the apex, where it ends in a hook called the *hamulus.* The membranous part of the lamina completes the outer portion of the septum and is attached to the inner surface of the tube of the cochlea, it is the converse of the osseous plate, and is broader above than below, where it forms the entire septum.

Both the osseous and membranous portions of the lamina spiralis consist of two thin plates, leaving a space, in which the cochlear nerves and vessels are distributed. This lamina spiralis or septum of the tube of the cochlea, divides the tube into the *scalæ.*

The *Scalæ* are two in number—the one communicating with the vestibule called *scala vestibuli*—the other, with the tympanum, named the *scala tympani.* These scalæ are separated throughout their whole extent, except at the summit of the cochlea, over the hamulus, where they communicate by one common opening. The scala vestibuli is external and superior—while the scala tympani is internal and inferior.

The *Modiolus* constitutes the central axis, or pillar of the cochlea, extending from its base to its apex, around which both the tube and spiral lamina make their turns. It arises from the bottom of the internal auditory meatus, as a bony process, forming a conical tube which proceeds horizontally outward, and contracts as it reaches the apex. The base of the modiolus is perforated with foramina, for the passage of the auditory nerves. Its funnel-shaped summit is called the *infundibulum,* and is arched over, or surmounted by the blind apex of the tube of the cochlea, named the *cupola.* The surface of the modiolus presents numerous canals

which open by foramina, corresponding to similar canals on the lamina spiralis, for transmitting the auditory vessels and nerves. One of these canals, larger than the rest, the *tubulus centralis modioli*, passes on to the infundibulum, and conducts the terminal branch of the cochlear nerve, and the arteria centralis modioli.

The *aqueduct* of the *cochlea* extends from the scala of the tympanum, into which it opens, near the fenestra rotunda, to the lower surface of the petrous bone near the jugular fossa—like the aqueduct of the vestibule, it simply carries a vein, and is closed by the dura mater.

Semicircular Canals, (Fig. 108.)—These consist of three bony tubes, representing so many cylinders of equal diameters, and forming about three-fourths of a circle. They are situated within the substance of the petrous bone behind the vestibule, into which they open by five distinct orifices. Two of these canals are perpendicular, and the third horizontal. They are the *anterior* and *superior vertical*, *posterior* and *inferior vertical*, and the *horizontal*.

The *superior vertical* makes a projection on the upper surface of the petrous bone—crosses it transversely, its outer extremity opening, by an ampulla, into the superior cornu of the vestibule—while its inner unites with the upper crus of the posterior vertical, forming a common tube, which enters, by a single orifice, into the posterior cornu of the vestibule.

The *posterior vertical canal* is at right angles to the superior, and parallel to the posterior surface of the petrous bone. It opens, by one extremity, into the posterior cornu; and by the other it forms, with one end of the superior, a common canal, opening also into the same cornu of the vestibule.

The *horizontal* is the shortest of the canals, and enters, by an ampulla at one end, into the superior cornu; and at the other end, into the posterior cornu of the vestibule. The semicircular canals are thus seen to have, each at one of their extremities, a dilatation or ampulla—one at the outer end of the superior vertical. one at the inferior

end of the posterior, and one at the anterior end of the horizontal.

Membrane lining the Labyrinth.—This membrane is fibro-serous, and is to be distinguished from another to be presently described, called the membranous labyrinth. It resembles the dura mater in having an external and fibrous layer, acting the part of periosteum, and adhering to the bone, while its internal is free, smooth, and serous, secreting a fluid called the *liquor Cotunnii*, *perilymph*, or *aqua labyrinthi*. This membrane lines the vestibule, cochlea, and semicircular canals; and also the fenestra ovalis, and rotunda. The *lamina spiralis* also gets a covering from it on either surface; and these two layers, coming together at the free external margin of the osseous lamina, pass to the outer wall of the tube, and thus complete the septum between the two scalæ. It also sends processes into the aqueducts of the vestibule and cochlea.

The *membranous labyrinth* does not enter the cochlea, and is not so extensive as the osseous, though it has the same *form*. It consists of four layers—an *external serous*, a *vascular*, a *nervous*, and an *internal serous layer;* thus constituting a tube which floats between two fluids—the outer, the *perilymph*, or *liquor of Cotunnius*, secreted by the external serous layer, and separating it from the walls of the osseous labyrinth; and the inner, the *liquor of Scarpa*, or *endolymph*, contained within the membranous tube of the labyrinth itself, and secreted by its internal serous layer.

The membranous labyrinth contains two sinuses, and three membranous semicircular canals. The sinuses are the *common sinus*, or *vestibular ventricle*, and the *sacculus proprius*, or *vestibuli*. The common sinus is in the posterior part of the vestibule, and receives the openings of the five semicircular canals. It is distended by the liquor of Scarpa, and floats in the fluid of Cotunnius.

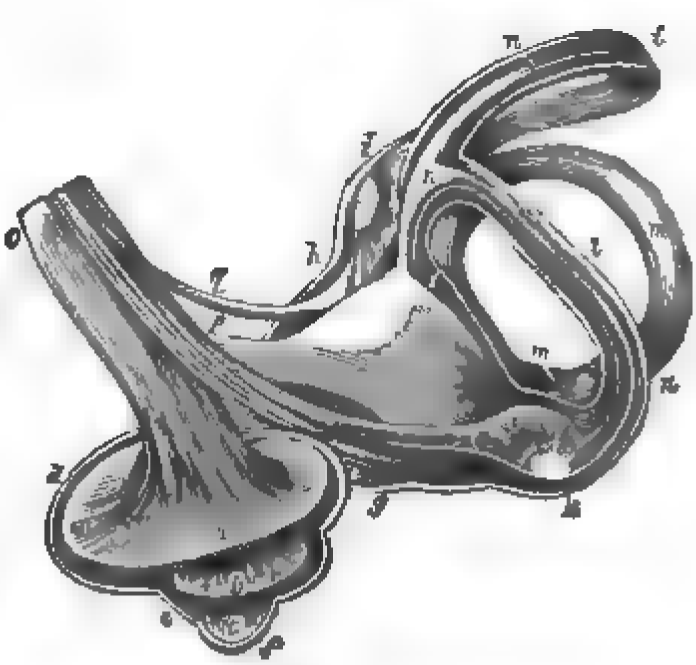
The *sacculus proprius* is situated anteriorly and inferiorly to the common sinus; it is round, and much smaller; but it is not settled whether the two have any communication, though they are in close contact.

The *membranous semicircular canals*, as has been stated, are much smaller than the osseous tubes in which they are situated, have the the same form, and present the same number of ampullæ. They are likewise distended with the fluid of Scarpa, and separated from the osseous semicircular walls, by the fluid of Cotunnius.

In the *sacculus communis*, and *proprius* of the vestibule, Breschet discovered two white, shining masses, composed of phosphate and carbonate of lime, held together by animal matter. Being in the form of powder, or dust, he called them *otoconia*, (οὖς, the ear, and κόνις, dust.) This ear-dust, or calcareous matter, floats in the fluid of Scarpa.

Nerves of the Ear.—The nerves of the ear come from the seventh, the fifth, the eighth pair—the cervical plexus, and the sympathetic. The portio mollis of the seventh pair is the especial nerve of hearing, entering the internal auditory meatus. It divides, at the cribriform base of this meatus, into two branches—the anterior and larger, going to supply the cochlea, and the posterior and smaller, passing to the vestibule and semicircular canals.

Fig. 109.



The *anterior*, or *cochlear* branch, has a spiral direction, and has been compared to a flat tape, rolled on itself. At the base of the meatus internus it enters the foramina, in the tractus spiralis, by numerous minute filaments which spread out upon the surface of the

Fig. 109 represents the Labyrinth, laid open and inverted, so as to show the distribution of its nerves. *a b c* Cochlea laid open. *d e f* Remains of the parietes of the cochlea. *g h* Vestibule. *i i* Superior semicircular canal. *k l* Inferior or horizontal canal. *m* Posterior canal. *n n* Semicircular membranous canals. *o p q* Auditory nerves passing to the labyrinth.

modiolus, and between the plates of the *lamina spiralis*. The posterior branch divides into the *superior*, *middle*, and *inferior*. The *superior* filaments enter the vestibule through the small foramina of the pyramid, and are expanded on the *sacculus communis*, and *ampullæ* of the superior vertical, and horizontal membranous canals. The middle set supply the *sacculus proprius*, and the inferior go to the ampulla of the *posterior vertical semicircular canals*. The *auditory nerve* is remarkable for its softness, and for its numerous divisions into minute branches, which anastomose together, and form an exceedingly delicate nervous membrane, having, according to some, the papillary form of termination.

The *Vidian nerve* bestows common sensibility, and coming from Meckel's ganglion belongs to the second division of the fifth. Entering the hiatus Fallopii, it joins the portio dura of the seventh in the aqueduct of Fallopius, and after a short distance, leaves it to enter the tympanum, and through a small foramen posterior to the pyramid. In this cavity it is called chorda tympani, and sends branches to the tympanic plexus; passes between the handle of the malleus and long leg of the incus, and escapes at the fissure of Glasser.

The portio-dura is a motor nerve and supplies the muscles of the tympanum with their power of motion.

The *tympanic plexus* seems to be the great source from whence all parts of the tympanum are supplied, as it is formed of branches from the chorda tympani, portio dura, glosso pharyngeal, par vagum, and sympathetic; supplying the membrana tympani, and lining membrane of the cavity, the fenestra ovalis, the Eustachian tube, the muscles, &c., and establishing relations with the soft palate, tongue, pharynx, eye, nose, and system generally.

Blood-vessels of the Ear.—The arteries of the labyrinth come from the *internal auditory*, which is a branch either of the *superior cerebellar* or the *basilar*. This enters the meatus along with the auditory nerve, pursues a similar course and divides into minute branches, supplying the vestibule, cochlea, and semi-circular canals.

The external ear, composed of the auricle and meatus, is supplied by the *anterior auricular*, branches of the *temporal*, and the *posterior auricular*, and *occipital* from the *external carotid*.

The middle ear is supplied from the *tympanic* branch of the *internal maxillary*, which enters at the fissure of Glasserus, and with a branch from the *stylo-mastoid*, forms a "coronet" round the membrana tympani, from which radiate numerous branches upon its surface. The internal carotid, as it passes through the canal, also sends a branch to the tympanum.

General Remarks.—In looking at the different parts composing the ear collectively, and their several relationships with one another, it seems manifest that the *external ear*, like a trumpet, is designed to collect and concentrate the sounds which fall upon it, that the *meatus externus* conducts and reflects from every part of its surface the sonorous undulations to the *membrana tympani*, that this membrane is then thrown into vibrations, and forming the outer wall of the middle ear, transmits its vibrations to the little *chain of bones* within the tympanum, with which it is connected, that these in their turn, being attached to the *membrane of the vestibule* by means of the stapes, throw it also into similar vibrations, which are now communicated to the *fluid* and *nerves* of the *labyrinth*, whence the impressions are finally conveyed to the sensorium. The air in the tympanum, by means of the Eustachian tube, it should have been stated, is a very essential aid in favoring the vibrations, and in conducting them in their progress to the auditory nerve.

SECTION III.

THE TONGUE OR ORGAN OF TASTE.

Taste is the faculty which the tongue possesses, in the discrimination of sapid bodies. This power also resides in the palate and lining membrane of the mouth, though not to the same extent as in the tongue.

The anatomy of the tongue (Figs. 86, 87, 88, 90, 91,) has been given under the head of "organs of deglutition." It was there stated to be very complex in its structure, and to perform a variety of functions; composed of no less than ten muscles, by which it can be moved in every possible direction. It is most efficient in the first stages of digestion, and is moreover, in man, the great instrument of speech. It has no less than six large nerves, by which it is endowed both with general and special sensation, i. e. the general sense of feeling and the special sense of taste. Glands likewise enter into its composition, an immense number of blood-vessels ramify throughout its substance, and the whole is covered by mucous membrane; so that the tongue is one of the most complex and highly organized portions of the body.

The *papillary membrane* of the tongue is regarded as the especial seat of taste, and is the only portion of its structure requiring any remarks in this place, in addition to what has already been given. This papillary or gustatory membrane has the closest analogy with the skin, and is considered as possessing essentially the same elements. Its *chorion* or *cutis-vera* is as dense as any part of the skin, and has a large number of muscular fibres inserted into it, by means of which its papillæ can be brought readily into contact with every portion of food; and thus this muscular appendage to the papillary membrane is regarded as playing an essential part in the function of taste. Its papillæ are like those of the skin, but larger and much more developed. Its rete mucosum has the same indistinctness. Its epithelium is distinctly shown, and has received the name of *periglottis*, having in some animals the consistence of horn.

The epithelium of the tongue can be removed by maceration and by certain inflammatory diseases, and is found to have an arrangement precisely like the epidermis of the skin, and to form a sheath of protection to the several papillæ upon its surface. These papillæ are very numerous, and were stated to have various names according to their size and shape, as the *papillæ maximæ*, *mediæ*, *fungiformes*,

filiformes, &c. The minute structure of the papillæ is believed to consist essentially of capillaries and nerves. The capillaries are seen disposed in the form of arches and loops, while the precise arrangement of the nervous tissue, which is very soft, is not ascertained.

The *anterior*, *lateral*, and *posterior* parts of the dorsum of the tongue possess the faculty of taste in the highest degree; the anterior and lateral papillæ being thought the most quickly sensitive to the qualities of sapid bodies, while the posterior retain their impressions for a longer time.

The papillæ and tongue are most abundantly supplied with nerves which come from three sources; the *ninth* or *hypoglossal*, the *glosso-pharyngeal*, and the *lingual* or *gustatory* branch of the fifth. The question now is, which of these nerves is the nerve of taste? The ninth nerve, it is pretty well agreed, is one of motion, and supplies the different muscles of the tongue. The glosso-pharyngeal is found to be exclusively distributed to the mucous membrane, and its papillæ covering the base of the tongue; while the gustatory goes to the papillæ on the tip and sides of the tongue. Hence these two latter nerves are regarded as the source of common sensation and the special sense of taste. The glosso-pharyngeal is also regarded as the medium of sympathy between the tongue and stomach, and as combining in harmonious concert all the various organs concerned in deglutition.

SECTION IV.

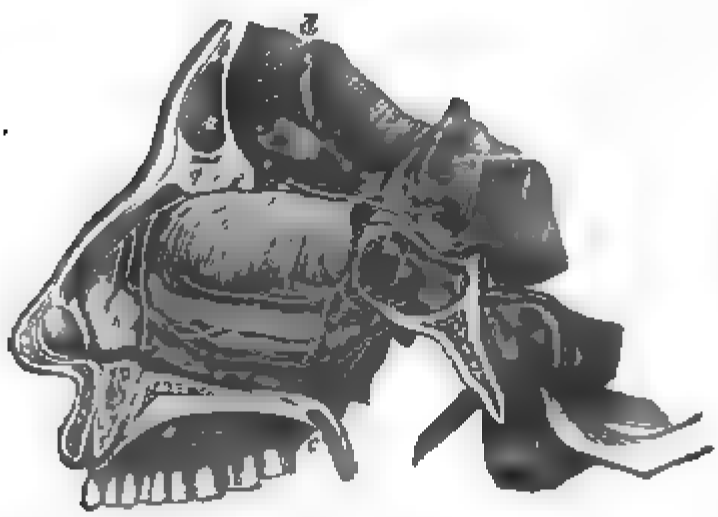
THE NOSE OR ORGAN OF SMELL.

The *nose*, occupying a *situation* between the orbits, above the mouth and in front of the pharynx, is a symmetrical organ placed along the median line of the body. It consists of a variety of parts adapted to the purposes of smell, and is likewise an open avenue for the free passage of the air during respiration.

Its anatomical elements include bone, muscle, cartilages, blood-vessels, and nerves, covered by the common integu-

ment. The bones are the *ossa-nasi*, and *nasal processes* of the *superior maxillary bones*, which have been already de-

Fig. 110.



scribed among the passive organs of the head. The muscles are the *pyramidalis nasi*, *compressor nasi*, *levator labii superioris alæque nasi*, and *depressor labii superioris alæque nasi*. These also have been described under the head of organs of expression and prehension.

The cartilages constitute an important division of the *external portion* of the nose, and are five in number, one *central*, two *lateral*, and two *alar*. The *central*, *median* or *septal* cartilage, separates the nostrils, is of a triangular *form*, and is connected above with the nasal bones and lateral cartilages, below with the palate processes of the superior maxillary bones, and posteriorly with the vomer and æthmoid septum. It is flexible, elastic, and has considerable strength.

Its anterior border is thick and rounded, and though generally vertical, it occasionally projects to the one side, being concave on the opposite.

The *lateral*, or *fibro-cartilages*, are connected superiorly and externally with the inferior edge of the nasal bones, and anterior margin of the nasal process of the superior maxillary; in front with the nasal septum, and below with the alar cartilages.

The *alar cartilages* occupy the anterior part of the nasal openings, and are so curved as to form the rim, or boun-

Fig. 110 represents the first pair or olfactory nerves. *a* Frontal sinus. *b* Sphenoidal sinus. *c* Hard palate. *d* Olfactory bulb. *e* Branches of olfactory on the superior and middle turbinated bones. *f* Spheno palatine nerves from the second division of the fifth. *g* Internal nasal nerve from the first division of the fifth. *h* Branches of *g* to the Schneiderian membrane. *i* Ganglion of Cloquet. *j* Anastomosis of branches of the fifth or lower turbinated bone.

dary. At the point of the nose, these cartilages are thick and constitute the *tip*, or *lobe;* each passes round the orifice of the nostril, in a semicircular form, having its internal surface deeply concave, by which the nostrils are enlarged. As they make their curve, they become widened at their posterior part, by having, as appendages, three or four small cartilaginous plates connected by fibrous tissue. The two alar cartilages meet, in front, beneath the septum, and are attached, by fibro-cellular tissue, to the nasal spine of the superior maxillary bones, forming a projection called the *columna.* All these cartilages are connected, by fibrous tissue, to one another and to the bones, and are readily movable, by the muscles attached to them, so as to enlarge or contract the anterior nares at pleasure.

Each nostril has its entrance protected by some stiff hairs, called *vibrissæ*, which prevent the introduction of foreign bodies, along with the air, in breathing.

The *integument* of the nose is thick and dense, and so closely attached to the cartilages, as with difficulty to be separated from them. It is supplied with numerous sebaceous follicles, whose ducts open upon the surface and frequently present the appearance of numerous black dots, from the presence of carbon. This sebaceous secretion becomes solidified, and, by pressing the follicles, can be forced out in fine, long threads, which have been compared to "small, white maggots with black heads." These follicles are liable to hypertrophy, and occasionally become so large as to present a very tuberculated and unsightly appearance.

The use of this secretion, which is of an oily nature, is to preserve the skin of the nose in a soft and pliable condition, as well as to guard against excessive changes in temperature.

Nasal Fossæ, (Fig. 111.)—The *nasal fossæ* constitute the *internal* or posterior part of the nose, forming its second division. They consist of two very irregular cavities extending back to the *pharynx*, and bounded above by the *nasal cartilages*, *nasal*, *frontal*, *æthmoidal*, and *sphenoidal* bones,

forming the roof of the nostrils; below by the palatine processes of the *superior maxillary* and *palate bones*, with a portion of the velum palati, constituting the floor of these fossæ, as well as of the nostrils; externally they are bounded by the *superior maxillary, lachrymal, æthmoid, turbinated*, and *palate* bones, and the *internal pterygoid plate* of the *sphenoid;* internally they are separated, on the median line, by the *septum* composed of the *vomer*, the *nasal lamella* of the *æthmoid*, and the *nasal cartilaginous septum.*

Fig. 111.

The outer wall is very irregular, being roughened by the three turbinated, or spongy bones—the *superior, middle*, and *inferior.* These have spaces between them, known as *meatuses.* As the space between the superior and middle spongy bones is the *superior meatus;* that between the middle and lower is the *middle meatus;* and that between the lower and floor of the nostrils is the *inferior meatus.* Into the superior meatus the *posterior æthmoid cells* and *sphenoid sinuses* open.

The *middle meatus* is the widest, and opens into the *antrum.* In the dry bone this opening appears large; while in the fresh state it will only admit a small probe, being closed by a fold of the mucous membrane. It receives the *anterior æthmoid cells*, and has in its front part a groove called the *infundibulum*, which leads to the *frontal sinus.*

Fig. 111 represents a vertical section of the Nasal Fossæ. 1 Anterior fossæ of the cranium. 2 Dura mater, covering the fossæ. 3 Dura mater raised. 4 Cristagalli of æthmoid bone. 5 5 Cribriform plate. 6 Nasal lamella. 7 7 Middle turbinated bones. 8 8 Æthmoid cells. 9 9 Os-planum. 10 10 Inferior turbinated, or spongy bones. 11 Vomer. 12 Superior maxillary bone. 13 Articulation of superior maxillary with the æthmoid. 14 Front wall of the antrum. 15 Fibrous membrane of the antrum. 16 Mucous membrane of antrum. 17 Palatine process of superior maxillary bone. 18 Roof of the mouth. 19 A section of the mucous membrane.

The inferior meatus has the *nasal duct* opening into its anterior portion—while the *Eustachian tube* is seen behind on a level with the inferior spongy bone.

These different meatuses constitute so many channels, extending from before backward, in the nasal fossæ, which with the spongy bones, present a large amount of surface covered by mucous membrane, upon which the air in passing along, makes odorous impressions.

The mucous membrane lining the nasal-fossæ is called the *pituitary* or *Schneiderian membrane.* It is attached to the internal surface of the bones of the nose, lines the sinuses, is traced into the *æthmoid* and *sphenoid cells,* passes through the *nasal duct,* and is continuous with the *tunica conjunctiva* of the eye. Backward through the posterior nares, it becomes continuous with the mucous membrane of the mouth and pharynx, and consequently with the great gastro-pulmonary division. In some parts it is very vascular, soft, and thick, as on the turbinated bones and septum. In other places it adheres strongly to the periosteum. It is pale and thin in the sinuses. It is constantly moistened with mucus, and, like mucous membranes elsewhere, has its surface covered with an epithelium. This epithelium is of the columnar form, except in the sinuses where it is found to have more of the squamous character. It is every where observed to be furnished with cilia, whose vibratile motions, it is believed, have an important influence in directing the mucus towards the various openings by which it is discharged.

Blood-vessels of the Nose.—The terminating branches of the *facial artery* supply the external nose, while the *anterior* and *posterior æthmoidal* of the ophthalmic, with the *spheno-palatine* and *pterygo-palatine* of the internal maxillary, supply the nasal fossæ or internal nose.

Nerves.—The olfactory or first pair, (Fig. 110,) are the special nerves of the nose and of the sense of smell; their development being always found in the lower animals in proportion to the acuteness and development of this sense. They come from the brain through the foramina in the

cribriform plate of the æthmoid bone, enveloped by fibrous sheaths, and are distributed mostly upon the superior part of the pituitary membrane, forming plexuses in its substance. The branches of the olfactory are seldom found to pass lower than the middle spongy bone and the middle part of the septum. "Thus," as Cruveilhier remarks, "while the upper and extremely narrow part of each nasal fossa is the essential seat of the sense of smell, the lower and much wider part only gives passage to the air during the act of respiration."

Besides the special sense of smell, there is also the general sense of feeling derived from the first and second divisions of the fifth pair, or branches from the ophthalmic and superior maxillary nerves, which are likewise distributed to every part of the nose. These branches from the fifth, differ from the olfactory in not having the plexiform arrangement.

SECTION V.

THE SKIN OR ORGAN OF TOUCH, (Fig. 19.)

The sense of touch is coextensive with the whole external cutaneous surface, and those portions of the internal cutaneous or mucous, which are adjacent to the skin and continuous with it. The diffusive character of the sense of touch, and the extent of the apparatus composing it, distinguish it from the rest of the senses, whose limits are circumscribed and confined solely to the head and face. Though it be true that the sense of touch resides generally in the skin, yet it is also true that there are some portions in which it is much more highly developed, and where the sense of touch is said most especially to reside—that is in the skin covering the extremities of the fingers and toes—and here it is discriminated by the name of *tact.*

The sense of touch enables every one to recognise the pressure and presence of external bodies, when they come in contact with his skin, also to determine many of their physical properties, as form, size, weight, consistence and temperature. But for the discernment of other qualities of

a more refined character, a proportionate refinement of organization seems necessary, and this is found in the tips of the fingers.

The skin is also an organ of secretion and absorption. The secretion is of two kinds, of which one is a separation from the blood of a very fine halitus, the insensible perspiration, or *exhalation*. When this exhalation is in excess and forms drops, it constitutes the sweat. This is a very important function, as it relieves the blood of a large amount of water, saline matters, carbonic acid and other substances, which, if retained, would be injurious to the system. The perspiration by evaporation acts as a cooling process, and is thus highly useful in carrying off the excessive heat of the body. The other secretion of the skin is of an oily nature, which keeps it in a soft and pliant condition, protects it from the drying agency of the air, and shields it from external moisture. It is also an organ, as stated, of absorption.

The skin performing so great a variety of functions, must necessarily possess a very complex organization. Its anatomy has been given already in detail, under the head of the "cutaneous tissue," in the first part of this work. It is there stated to consist of three membranous layers superimposed the one upon the other, and called the cuticle, rete mucosum, and cutis vera, of numerous glands and follicles, with a most minute and extensive capillary network of arteries, veins, nerves, and lymphatics. In addition to these there are also the appendages of the hair and the nails.

The only part of the structure of the skin, therefore, necessary to make any additional remarks upon, is the papillary layer or that portion directly connected with the sense of touch. This layer abounds with numerous papillæ spread every where over its surface, but more distinct and of greater size in some places than in others. The fingers and toes, and the palmar and plantar surfaces of the hands and feet have them most highly developed. The skin upon the ends of the fingers, where the sense of

25

touch most especially resides, presents ridges and grooves of an arched or curved form; each ridge is a row of conical papillæ, and in the grooves the exhalant orifices are found to open. The minute structure of the papillæ consists of blood vessels, nerves, and a spongy erectile tissue, and is believed to be exactly analogous with those of the tongue. The vessels are seen as convoluted loops, but the precise termination of the nerves, whether in loops, plexuses, or bulbs, is not yet settled.

That the *papillæ*, however, are exceedingly sensitive, and constitute the essential seat of touch, there is no doubt.

The mucous membrane of the eyelids, nose, mouth, larynx, trachea and lungs, is sensible to heat and cold, while that of the vagina, rectum, and urethra, is in addition sensible also to touch.

CHAPTER V.

INTERNAL ORGANS OF SENSE.

The *internal organs of sense* comprise the *cerebro-spinal axis*, by which is understood the *brain* and *spinal marrow*. These organs are the *source* of sensation and motion to all the organs we have been examining, as those belonging to the mouth and face and external parts of the head. They constitute the foundation and main-spring of all their actions, and without them the functions of these subordinate organs could not be exercised. The examination of the brain and spinal marrow, then, as the source of power to all these parts, seems to follow very naturally, and comes next in the order of investigation we have thought best to pursue.

This will make complete the anatomy of the head, and carry out the design in view, which is to endeavor to illustrate as far as possible, *practical physiology*, by bringing organs together, however dissimilar in structure, which have a relationship or community of action in the discharge of any particular function or series of functions; and thus

show, step by step, the relative dependency of the several parts, and the inseparable union of the anatomy and physiology of the whole, in the great business of continuing and preserving life.

The brain and spinal marrow are not only the sources of power to the different parts of the head, but they are further the great centres of action to the whole nervous system and all its dependencies.

We shall consider the cerebro-spinal axis in the natural order of its development, beginning with the spinal marrow.

SECTION I.

SPINAL MARROW. (Fig. 14.)

The *situation* of this organ within the spinal canal, together with its divisions, structure, and functions, has already been partly considered under the head of nervous tissue. A few more additional remarks will be all that is necessary in this place.

The spinal marrow, (medulla spinalis,) in common with the brain, has three membranes surrounding it, the *dura mater*, *tunica arachnoidea*, and *pia mater*—the whole enclosed in a strong bony case, called the vertebral or spinal canal.

Dissection.—After removing the soft parts covering the spine, divide, with the saw, the crura of the spinous processes, close to the roots of the transverse, the whole length of the canal; then raise this portion with an elevator, when will be first seen a considerable amount of soft, reddish cellular and adipose tissue, between the bones and the membranes of the spinal cord, which at this point have a very loose connection—while in front the dura mater is closely attached to the bodies of the spine, by means of the posterior ligaments. It will also be noticed that the spinal marrow does not fill, by a considerable space, the whole diameter of the bony canal.

The *Dura Mater*, (*mater*, mother,) so called from being formerly supposed, by the older anatomists, to be, along

with the pia mater, the mother membranes, which give origin to all the rest of the body, is the outer one, covering the spinal cord, and continued upon the brain. It is called *theca vertebralis*, and extends from the foramen magnum, to which it adheres, down the spinal canal its whole length, to the sacrum, where it sends off several processes forming sheaths for the sacral nerves. It differs from the cranial portion, at the posterior part of the canal, in not being connected with the bones; but having, interposed between it and the bony arches, a soft fatty tissue, which has been compared to the marrow of the long bones. The external surface, at this point, is smooth and covered by a plexus of veins. In front, as just stated, it is attached to the posterior vertebral ligaments. On each side it sends off a tubular process or sheath, for each of the spinal nerves, which extends beyond the intervertebral foramina, and becomes lost on the cellular tissue.

It has a much greater capacity than the cord it encloses, is larger in its upper and lower portions, and contracted in the middle. Its inner surface is smooth, and presents double rows of openings through which pass the anterior and posterior roots of the spinal nerves; here also is seen the attachment of the ligamenta denticulata, or tooth-like processes, disposed laterally.

Structure.—Its structure is essentially fibrous, having the fibres, which are white, running in various directions, and in some places, as in the brain, separable into two laminæ. It is a strong, resisting, inelastic tissue, resembling the sclerotic coat of the eye, and, like it, admirably adapted for protecting the spinal marrow and the brain.

The blood-vessels of the spinal portion of the dura mater are the arteries which come from the vertebral, intercostal, lumbar, and sacral. The veins accompanying the arteries are found to terminate in the two long *vertebral sinuses*, which extend the whole length of the spine on the back part of the bodies of the vertebræ.

Tunica arachnoidea (αραχνη, a spider's web, ειδος, likeness) is the next membrane, after removing the dura mater, and

takes its name from its extreme tenuity and transparency. It lines the dura mater, and is reflected from it upon the nerves to the spinal cord, which it loosely covers. Hence this membrane is much larger than the spinal cord, and allows of a considerable space between the two, called the *sub-arachnoid space.* This space is occupied by a serous fluid, which dilates the arachnoid, and is said completely to fill the cavity of the theca-vertebralis. This fluid is of use in keeping up a gentle pressure and giving support to the cord, and in filling up all the inequalities on its surface; allowing the greatest freedom in all its movements, and guarding it against concussions. The portion of the arachnoid covering the dura mater is called *parietal,* that upon the cord is the visceral, and the space between the two constitutes the arachnoid cavity, not found to contain much fluid. It forms a sheath for the nerves and is reflected back upon the theca, forming at each nerve a small cul de sac. Between the anterior and posterior roots of the nerves little reflections or tooth-like processes of this membrane, about twenty-two in number, are seen to extend from the pia mater, laterally along the spinal cord, and in a regular series, to be connected by their little points, to the inner surface of the dura mater. These processes are called the *ligamenta denticulata;* each encloses a fibrous band or thread, and the whole are designed to separate the anterior and posterior roots of the nerves, and to give support to the cord in the lateral direction.

The structure of the arachnoid is serous, and presents the usual smooth, glistening, delicate and transparent appearance of serous membranes every where.

The *Pia Mater* forms the third and innermost covering of the cord. It is considered the same and continuous with that of the brain. But there is this important difference, that while the pia mater of the brain is essentially vascular, the pia mater of the spinal marrow is essentially fibrous, that of the brain being loaded with vessels, while that of the cord has very few. It is dense and strong, and compresses the cord to such a degree that, when opened, the

nervous matter of the cord protrudes. Its external surface is rather rough from the cellular and fibrous filaments connecting it with the arachnoid. On this surface are also seen large and tortuous vessels. Its internal surface is connected by delicate vessels and cellular threads to the cord. The pia mater, besides surrounding the spinal marrow, sends a duplication into both its anterior and posterior median fissure, and also gives a neurilemma to each nerve.

The *function* of this membrane is rather one of protection to the spinal cord, than that of a vascular membrane as upon the brain.

The *Spinal Marrow*, (Fig. 14,) it has been stated under the head of the nervous tissue, consists of two kinds of nervous matter, the white and the gray, not disposed as they are in the brain. The white or medullary forms the whole exterior covering, while the gray or cineritious occupies the interior.

Besides its division into two lateral and symmetrical parts by the anterior and posterior median fissures, and the lateral subdivision of these, by two other fissures, so that each half of the cord consists of three columns or rods, according to Sir Charles Bell, the anterior and posterior columns, and the middle or respiratory tract; two others have been added by some, making the cord consist of eight divisions, four on each side of the median fissure, in the following manner: first, the *anterior*, between the median fissure and anterior nerves; second, the *lateral* between the roots of the nerves; third, the *posterior* between the posterior fissure and posterior nerves; and fourth, the *posterior pyramids*, situated only at the upper part of the cord, and close to the posterior fissure.

Another division of the spinal marrow, and one thought most natural, is the blending together of the anterior and middle columns, under the head of *antero lateral*, and counting the posterior column as one, making but four in all. The bottoms of the anterior and posterior fissures, have transverse bands or commissures, extending from side to side, and connecting the lateral halves of the spinal cord.

According to the experiments of Sir Charles Bell, Magendie, and others, it has also been stated that the anterior columns of the spinal marrow are the sources of motion, and the posterior those of sensation.

It is also found that the medullary matter of the cord has longitudinal fibres extending to the brain, and that these medullary fibres are the media of communication between the brain and spinal marrow, being the conductors of all impressions to the brain, constituting conscious perception, and transmitters of all volitions from the brain, giving rise to voluntary muscular motions. But the spinal marrow has nervous fibres which stop within the cord itself, and do not go to the brain, and even without the brain are conductors, both of sensation and motion—but of a sensation which is not conscious, and a motion which is involuntary—powers which Mr. Marshall Hall has shown to be derived from the spinal marrow itself, acting as an independent ganglionic centre. The nerves which arise from, and terminate in it, he calls, as elsewhere mentioned, the *excito motory*.

ORIGIN OF THE SPINAL NERVES.

All the spinal nerves are compound, and arise by double roots—one anterior, the other posterior; the former arising from the anterior columns and being nerves of motion; the latter from the posterior columns, and designed for sensation. Each root consists of several filaments. The anterior roots are smaller than the posterior, except the first, or sub-occipital, and are separated from each other by the ligamentum denticulatum. These roots approach each other, and perforate the dura mater separately, each receiving a sheath from it. On the posterior root a small oval ganglion is seen; and immediately beyond the ganglion, the two roots come together and constitute a proper spinal nerve. The number of spinal nerves is thirty-one, eight cervical, twelve dorsal, five lumbar, and six sacral; though some anatomists make but thirty, and others thirty-two.

The ganglia are reddish, firm bodies, situated in the

intervertebral foramina, except those of the sacral and coccygeal nerves, which are found in the spinal canal. Each of the spinal nerves, after leaving the intervertebral foramen, divides into anterior and posterior branches. The anterior, with the exception of the first two cervical, are much larger than the posterior, and unite to form the several plexuses, constituting the cervical, brachial, lumbar, and sacral, which supply the muscles anterior to the spinal column, and the upper and lower extremity. The posterior supply the parts on the back of the spinal column.

BLOOD-VESSELS OF THE SPINAL MARROW. (Fig. 8.)

The spinal cord is supplied with arteries from the vertebral, intercostal, lumbar, and sacral.

The vertebral, at the foramen magnum, sends off the anterior and posterior spinal arteries, which descend the whole length of the cord, in front and behind. Branches of the intercostal, lumbar and sacral, enter through the intervertebral foramina, to supply the cord.

The *veins* are numerous. One on each side of the middle line, from its size, is called the *sinus columnæ vertebralis*, and is found on the posterior surface of the bodies of the vertebræ, between them and the dura mater. Branches running transversely join these sinuses; and there is also an anastomosis with the veins on the outside of the spinal canal.

SECTION II.

THE BRAIN. (Fig. 16.)

The brain is regarded as the great central portion of the nervous system, and being situated within the cavity of the cranium, is called the *Encephalon*, (ενχεφαλ, *within the head.*)

The brain has four principal divisions, which we shall examine in the natural order of their development, or from below upward:

1. Medulla oblongata.	3. Cerebellum.
2. Pons Varolii.	4. Cerebrum.

These several divisions are all covered by membranes which are common to the whole, and are the same as those of the spinal marrow, the *dura mater*, the *tunica arachnoidea*, and the *pia mater*. It is only necessary for us to point out the peculiarities of these membranes as pertaining to the brain.

Dissection.—Make an incision through the scalp, from the ear upon the one side, across the vertex to the opposite ear; turn the skin over the face in front, and upon the neck behind; now with the saw carry a circular incision through the first table of bone, commencing about an inch above the superciliary arches, and terminating a little below the external occipital protuberance. A few blows with mallet and chisel will separate the internal table, and the calvarium can be readily removed. The brain should now be removed from the cavity of the cranium, which can be done by commencing at the anterior part, and gently raising it from the base of the skull, dividing from before, backward, each nerve and vessel in succession, close to the bone; divide the tentorium, and cut the spinal marrow as low in the neck as can be reached, when the brain can be removed.

Dura Mater.—The dura mater of the brain is continuous with that of the spinal marrow, is of great strength, and performs no less than five different offices: first, it acts as a periosteum to the inner surface of the cranium; second, it gives a secure covering to the brain, especially needed in early life when the bones are separated; third, it sends in processes which divide and support the different parts of the brain; fourth, it forms the different sinuses; and fifth, it gives sheaths to the several nerves as they leave the cranium. Its *external surface* has a strong adhesion to the internal surface of the cranium, so that it presents a rough appearance from the rupture of vessels and fibres connecting the two. The adhesion is strongest at the base, and along the course of the sutures. It adheres to the lesser wings of Ingrassias, the petrous edge of the temporal bone, sends processes through the several foramina of the

cranium, which are continued into the periosteum, and through the optic foramen around the optic nerve, into the sclerotica of the eye. At some points the attachment to the bones is much more feeble than at others, as in the occipital fossæ, and upon the squamous and parietal bones.

The strength of this connection varies at different periods of life. In the young it is so strong as to require the scissors, and considerable force, to effect a separation. In the adult the attachment is more easily broken; while in old age it becomes so strong again as to tear in shreds in the attempt at separation.

When the cranium has been successfully removed, its external surface, besides its roughness, also presents numerous red dots, which is owing to the rupture of vessels that form a part of the bond of union.

On the vertex, the dura mater has a cribriform appearance, having little, granular, pale bodies projecting from it, called *glandulæ Pacchioni*, which we will notice again presently. Raise the dura mater by making an incision through it on either side of the middle line; its *internal* surface is found to be smooth, polished, and lubricated with serum.

Its *structure* is fibro-serous. The fibrous layer, forming a very strong and firm capsule for the brain, consists of two lamina, the outer acting as the periosteum, the inner going to form the different reflections of the brain. Its serous layer is the reflected or parietal portion of the arachnoid, strongly adhering to the dura mater, and always in contact with the surface of the brain.

Blood-vessels, (Fig. 8.)—The arteries supplying the dura mater come from the *ophthalmic* and *internal carotid*, which send branches to its anterior portion. Its lateral parts are supplied by the *middle meningeal artery*, a branch of the internal maxillary, its posterior portion by the *occipital* and *vertebral*, and its basilar by the *pharyngeal*, *vertebral* and *internal carotid*. Its veins enter the sinuses, except those of the middle artery, which are venæ comites.

The *nerves* are few and small, and not easily traced. Branches, however, are found going to the dura mater from the fifth pair, and branches from the sympathetic accompany the meningeal artery. In consequence therefore of the paucity of the nerves, the sensibility of this membrane is rather dull.

Reflections of dura-mater.—The principal of these reflections are the falx cerebri, tentorium, and falx cerebelli. The falx cerebri (*falx*, a sickle) is a process, of a sickle-like shape, from the dura mater along its median line. It is situated between the hemispheres of the brain, which it separates, and extends from the foramen cœcum and crista galli of the æthmoid bone, proceeding by its superior border along the middle line of the frontal bone and the sagittal suture of the parietal bones, back upon the upper half of the vertical ridge of the occipital bone, to the tentorium, upon which it rests and with which it is continuous; as it ascends it describes a curve, increasing in depth as it proceeds upward, having its superior border broad and convex, containing the superior longitudinal sinus, while its inferior is sharp and concave, enclosing the inferior longitudinal sinus.

The *tentorium* is stretched horizontally across the inferior part of the cranium, separating the cerebrum from the cerebellum. It is seen by lifting the posterior lobes of the cerebrum, and is connected by its convex border to the transverse ridge and tubercle of the occipital bone, the inferior posterior angle of the parietal, the superior ridge of the petrous, and the clinoid processes of the sphenoid. The tentorium is convex above and concave below, and derives its name from its being arched in the centre like a tent. Along its convex border are the two lateral sinuses, and upon its median line is the straight sinus. At its anterior part is a large oval foramen occupied by the pons Varolii, crura cerebri, and the superior vermiform process of the cerebellum.

The *falx cerebelli* is situated below the tentorium, upon the inferior occipital ridge, and separates the hemispheres

of the cerebellum. Its convex border encloses the two occipital sinuses. Its direction is vertical, extending from the tentorium above, to the foramen magnum below. Other reflections of the dura mater, called *sphenoidal* folds, are seen on the sides of the sella turcica, forming the cavernous sinuses.

Sinuses of the dura mater, (Fig. 112.)—All the sinuses are formed by reflections of the internal lamina of the dura mater, separating from the external, and leaving large triangular cavities between them, lined with the same membrane as that of the veins, all communicating with each other, and designed for receiving the venous blood of the brain. As many as fifteen sinuses are enumerated; five of these being in pairs and five single. Those in pairs are the two *lateral*, two *superior petrosal*, two *inferior petrosal*, two *occipital*, and two *cavernous*. The single are the *superior* and *inferior longitudinal*, the *straight*, *transverse* and *circular*. Others again make only eight, while Mr. Tuson gives nine, which is the most commonly received number. They are the following:

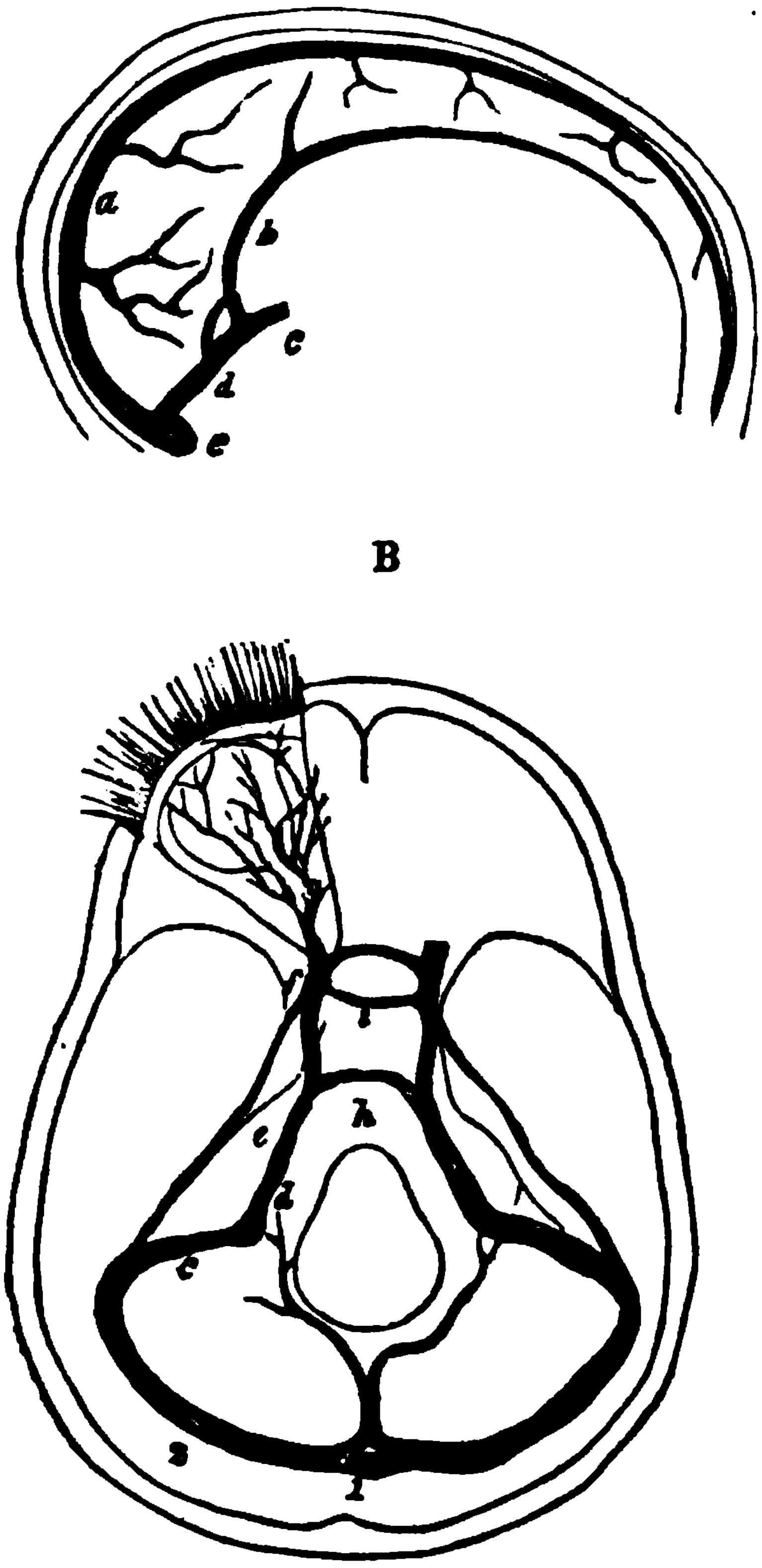
1. Superior longitudinal sinus. 2. Inferior longitudinal sinus. 3. Two lateral sinuses. 4. Vena magna Galeni. 5. The superior petrosal sinus. 6. Inferior petrosal sinus. 7. The two carvernous sinuses. 8. Circular sinus of Ridley. 9. Torcular Herophili.

In this, however, it will be seen there is no mention of the occipital sinuses. The superior longitudinal sinus, as just stated, describes the course of the superior margin of the falx major; when opened its form is seen to be triangular, its base being above and its apex below, in the falx—little fibres called *cordæ-Willisii*, are seen to cross it in different places; numerous orifices are seen throughout the whole extent of this sinus, corresponding to the entrance of the veins from the cerebral hemispheres, dura-mater, diploe, and pericranium.

The *glandulæ Pacchioni* are seen connected with this sinus in two positions, first on the outside of the dura mater and near the sinus; and second within the sinus. They are

FIG. 112. A

B



also found upon the arachnoid membrane. These glands, as they are called, consist of small, round, whitish bodies, found in clusters or singly, and varying in number, size, and appearance.

The inferior longitudinal sinus resembles a vein, and receives the veins of the corpus callosum. It ends in the straight sinus.

The *two lateral sinuses* are the largest, and formed by the junction of the longitudinal and straight. They commence at the internal occipital protuberance, course outward along the convex border of the tentorium, within the horizontal occipital groove, thence along the channel in the mastoid portion of the temporal bone, and finally pass out of the skull at the foramen lacerum posterius to become the internal jugular veins of the neck.

The *vein of Galen* corresponds to the *rectus* or straight sinus which is situated between the laminæ at the base of the falx major, where it rests upon the tentorium. It receives

FIG. 112, A represents the sinuses of the dura-mater. *a* Superior longitudinal sinus. *b* Inferior longitudinal sinus, both of these sinuses are in the falx cerebri. *c* Veins of galen. *d* Rectus or straight sinus. *e* Torcular Herophili.

FIG. 112, B represents the sinuses at the base of the cranium. 1 Opening of superior longitudinal sinus into the torcular Herophili. 2 Left lateral sinus. *d* Where the jugular vein commences. *e* Superior petrosal sinus. *f* Cavernous sinus. *g* Ophthalmic vein. *h* Transverse sinus. *i* Circular or coronary sinus of Ridley.

the veins of the septum lucidum, choroid plexus, corpora striata, and other inner portions of the brain, and terminates at the junction of the longitudinal and straight sinus.

The *petrosal sinuses* are four in number, two on each side. The superior are between the superior grooved ridge of the petrous bone and tentorium, the inferior at the root of the petrous bone, and both discharge into the lateral sinuses.

The *cavernous sinuses* are situated upon the sides of the sella turcica, receive the ophthalmic veins anteriorly, and connect posteriorly with the petrosal sinuses. Tendinous fibres are seen intersecting this sinus, and through it pass the internal carotid artery, the third, fourth, first branch of the fifth and sixth nerves.

The *circular sinus of Ridley* is situated in front and behind the pituitary body, almost surrounding it, and connected with the cavernous.

The *torcular Herophili* is situated upon the internal occipital protuberance, and forms the common point of junction of the longitudinal, lateral, straight, occipital and transverse sinuses

The *occipital sinuses* are situated in the falx cerebelli, receive veins from the spinal canal, cerebellum, and adjacent bone, and terminate in the torcular Herophili.

The *transverse sinus* extends across the cuneiform process of the occipital bone, and connects with the petrosal, cavernous, and lateral sinus of opposite sides.

The *tunica arachnoidea* forms the second covering of the brain, and is continuous with that of the spinal marrow. Like all serous membranes, it forms a shut sac, one portion of it covering the brain, called *visceral,* the other, or *parietal,* is reflected upon the dura mater. It presents the usual smooth, shining, transparent, and delicate appearance of serous membranes in general. *Its extent* is commensurate with the whole external surface of the brain, covering all its convolutions, but not dipping down between them. It also lines the interior of the dura mater, and can be traced into the ventricles lining their internal surface. The point at which this membrane is seen to enter

the ventricles is beneath the posterior lobes of the cerebrum, in front of the anterior edge of the tentorium, and below the veins of Galen, where will be noticed a small foramen or canal, leading forward above the pineal gland, and opening into the third ventricle. The arachnoid is more loosely attached at some points than others, leaving spaces, which are named according to their locations, as the *anterior*, *posterior*, *lateral*, and *superior sub-arachnoid spaces*.

Function.—To secrete a fluid serum which lubricates its surfaces, and prevents friction. When this fluid is in excess in the arachnoid cavity, that is, between its parietal and visceral portions, it constitutes that variety of dropsy known by the name of *hydrocephalus externus;* if the excess be in the ventricles, it is called *hydrocephalus internus.* It gives also a sheath to the veins as they enter the superior longitudinal sinus, and a covering to the nerves as they leave the brain.

The *pia mater* forms the third and innermost membrane of the brain. It differs from the spinal, with which it is continuous in being *vascular* instead of fibrous. It is immediately in apposition with the brain, and is much more extensive than the arachnoid; for it not only covers the whole of the external surface of all the convolutions, but dips down between, covering, every where, the external gray matter, and finally entering the ventricles, and there forming folds, such as the choroid plexuses, &c.

It can be drawn out from between the various convolutions and expanded, when it presents the appearance of an extremely delicate membrane loaded with vessels; hence its *structure* is regarded as essentially vascular. It is the nutritious membrane of the brain, the capillary arteries passing from it into the brain, and the veins going from it into the sinuses. Its *external surface* is in relation with the arachnoid, to which it is closely and inseparably attached upon the surface of the convolutions, while at the base of the brain, and in the different sulci, between the several convolutions, they are distinct and readily separated.

Its *internal surface*, as stated, is in contact with the brain, and united to it by the immense number of vessels passing from it into its substance.

MEDULLA OBLONGATA. (Fig. 16.)

The *medulla oblongata*, or *rachidian bulb*, is *situated* upon the cuneiform process of the occipital bone, occupying its concave surface, and forming the upper portion of the spinal marrow. It *extends* from the atlas, or first vertebra, to the pons Varolii, being represented as from "fourteen to fifteen lines in length, nine lines in breadth, and six in thickness." Its *shape* is conical, the base being above, the apex below. Like the spinal marrow, it has a median fissure in front and behind, dividing it into two lateral and symmetrical parts, each of which is again divided by three grooves, presenting upon its surface four eminences: the *corpora pyramidalia, corpora olivaria, corpora restiformia*, and *posterior pyramids*.

According to Mr. Solly, each lateral half of the spinal marrow consists of *antero-lateral* and *posterior columns;* the antero-lateral being again divided into two portions, not by any anatomical separation, but, he says, "physiologically;" the half or two-thirds of the anterior part being the *motor tract*, and corresponding to the corpora pyramidalia and olivaria of the medulla oblongata, each of which sends fibres to the cerebrum and cerebellum, while the balance of the antero-lateral column, with the posterior, is for sensation.

The anterior median fissure of the medulla oblongata is broader but not so deep as the spinal, of which it is a continuation. It is lined by the pia mater, and is connected by transverse commissural fibres. About an inch below the pons, this fissure is obstructed by the fasciculi of the anterior columns of the spinal marrow, crossing or decussating each other at the lower end of each pyramid. This decussation explains why injuries upon one side of the brain affect the opposite side of the body; but as all the fibres do not cross over, this further explains the occa-

sional exceptions, when the injury is felt on the same side.

The *Corpora pyramidalia*, or anterior pyramids, are situated upon either side of the median fissure, extending the whole length of the medulla oblongata, and represent two white, convex, and narrow bands, placed side by side. They each arise at the point of decussation, as above stated, by two sets of fibres—the one from the opposite anterior column of the spinal marrow—the other from the same side with itself. As they enter the pons they become constricted, and can be traced through it to the crura cerebri, forming their outer and anterior portions.

Corpora Olivaria, so named from their resemblance to an olive, are *situated* to the outside of the corpora pyramidalia, are shorter, and more convex than the pyramids, and separated from them and the restiform bodies by a groove. They consist of two beautiful white bodies, which proceed from the antero lateral column of the spinal marrow, and continue through the central portion of the medulla oblongata, extending to its posterior surface, forming the floor of the fourth ventricle. These bodies can be traced ascending behind the corpora pyramidalia, through the pons, to the posterior portions of the crura cerebri, and thence to the *tubercula quadrigemina*, and *optic thalami*. Some curved fibres, termed *arciform*, pass over the corpora olivaria from the pyramids to the corpora restiformia; they vary in number and size, and are regarded as commissural between the bodies with which they are connected.

The olivary bodies are found to exist only in man and the quadrumana. On being divided, a quantity of gray matter is seen, called the *olivary ganglion*.

The *Corpora Restiformia* (*restis*, a rope) are situated upon the side and posterior part of the medulla oblongata, separated from the corpora olivaria by a groove, and from each other superiorly by the fourth ventricle, and inferiorly by the posterior median fissure. They are continuous with the posterior and part of the antero lateral columns of the spinal cord, and are traced ascending and diverging

to the cerebellum. The corpora restiformia thus form the line of connection between the spinal marrow, medulla oblongata, and cerebellum. Mr. Solly calls these bodies *ganglia restiformia*, or the ganglia of the pneumogastric nerves.

The *Posterior pyramids* are seen on the back part of the cord on either side of the posterior fissure, in relation with the fourth ventricle, and continuous partly with the restiform, and partly with the posterior olivary bodies. They are found to commence as low down as the dorsal region, and to ascend as high as the fourth ventricle. They are viewed as commissural to the spinal cord and medulla oblongata. These posterior pyramids are also called *auditory ganglia*. The medulla oblongata, thus composed, is justly regarded as a most important ganglionic centre, or as Mr. Solly thinks, of six ganglia, three on either side of the fissure, i. e. the anterior, lateral, and posterior, in addition to the columns for motion and sensation.

Nerves of the Medulla Oblongata.—Between the pyramids and olivary are the ninth nerves, between the olivary and the restiform bodies are the eighth pair. From the olivary, by the side of the calamus scriptorius, are the auditory. The fifth can be traced also into the olivary, and the sixth are between the pyramids and pons.

PONS VAROLII.

The *Pons Varolii*, or *tuber annulare*, (Fig. 16,) so called from its arched or bridge-like form and its discoverer, is a white body, *situated* upon the top of the medulla oblongata, about the centre of the base of the brain, and between the cerebrum and cerebellum.

It rests upon the cuneiform process of the occipital bone at its junction with the sphenoid, by its inferior and anterior surface. Its superior and posterior surfaces are in relation with the tubercula quadrigemina, the fourth ventricle, and the aqueduct of Sylvius. The crura cerebri are connected to its upper extremity, the crura cerebelli to its sides, and the medulla oblongata to its lower extremity. Its in-

ferior surface is divided by a median groove, which receives the basilar artery.

Its *structure* externally is fibrous or medullary, and white; the superficial fibres on the lower surface, run transversely from the crus cerebelli on the one side, to the crus on the opposite side, thus making the pons the great *commissure* of the *cerebellum*. Beneath these transverse fibres, after turning them aside, is seen a quantity of cineritious matter, through which pass medullary fibres corresponding to the pyramidal tracts, intermingling with the transverse fibres, and proceeding onward to the crura cerebri.

The *size* of the pons is always found to be in direct proportion to the hemispheres of the cerebellum. When the cerebellum is very small or entirely wanting, the pons is likewise proportionally small or wholly absent. This fact is confirmed by comparative anatomy, as in birds, fishes and reptiles, the cerebellum being entirely wanting or only rudimental, the pons is equally wanting.

The pons is so connected with the medulla oblongata, cerebellum, and cerebrum, as to be regarded as having a *common relation* to the whole.

CEREBELLUM—LESSER OR INFERIOR BRAIN. (Fig. 113.)

Dissection.—Raise the posterior lobes of the cerebrum, or remove them entirely, and divide the tentorium, when the cerebellum will be exposed.

It is *situated* beneath the tentorium in the inferior occipital fossæ. Its *size* is estimated to be seven times smaller than the cerebrum, and according to Gall, larger in the female than the male. The average weight is about four ounces and a half. Its *form* is that of an "ellipsoid"—oval in the transverse diameter, and measuring from three and a half to four inches in this direction. Its antero-posterior diameter is from two to two and a half inches, and its vertical, in the thickest part, about two inches. It is *divided* into two lateral and symmetrical parts called hemispheres. This division is made by the anterior and posterior median fissures, or notches,

the latter of which contains the falx cerebelli. The posterior fissure, from its great depth, receives the name also of the *valley*, or *purse-like fissure*. The anterior one is broad, encloses the tubercula quadrigemina, and overlaps the fourth ventricle. Each hemisphere is again divided into lobes and lobules by the various sulci and furrows on its surfaces. Its *surfaces* are two—*superior* and *inferior*.

The superior surface is marked by lines or furrows which are concentric, presenting the form of large curves, parallel and concave forward. In the middle line,

FIG. 113. A

B

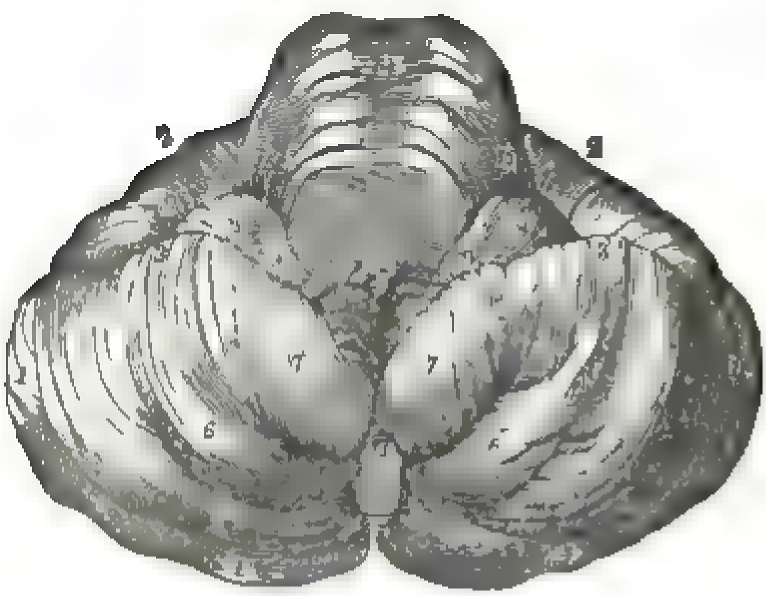


FIG. 113, A represents the superior surface of the Cerebellum. 1 1 Lateral lobes or hemispheres. 2 2 Anterior or square lobes. 3 3 Posterior or semicircular-shaped lobes. 4 4 Inferior semilunar lobe—its internal part. 5 6 Superior vermiform process. 7 The deep posterior fissure, separating the hemispheres, and covered by medulla oblongata, called the valley, or purse-like fissure. 8 Pons Varolii. 9 Superior fossa of cerebellum.

FIG. 113, B represents the inferior surface of the Cerebellum. 1 1 Lateral hemispheres, or lobes. 2 2 External and front portions of anterior lobes. 3 3 Great horizontal fissure. 4 4 The posterior or semilunar lobes. 5 5 Gracilis, or slender lobes. 6 6 Digastric, or anterior and external lobes. 7 7 Amygdaloid, or tonsillitic lobes. 8 8 Flocculus, or Pneumogastric lobes. 9 9 White substance of flocculus. 11 Inferior vermiform process. 12 Nodule. 13 Pyramid. 14 Pons Varolii. 15 15 Crura cerebelli.

and most prominent in front, is a ridge or process, called the *superior vermiform process*, or middle superior lobe, which is related with the valve of Vieussens—covers the tubercula quadrigemina, and connects the lateral lobes. One deep sulcus divides the superior surface of each hemisphere into an anterior and posterior lobe. The anterior stretches as far forward as the anterior notch, and is connected to its fellow by the transverse fibres of the superior vermiform process. The posterior extends to the convex border behind, and is also connected by transverse fibres. Both of these lobes are again divisible into smaller parts consisting of lobules, and laminæ, or leaflets.

The *inferior surface*, like the superior, is also marked by concentric lines, furrows, or sulci. It is divided from the superior by a horizontal fissure, which is deep and extends round the circumference of both hemispheres, as far forward as the pons. This fissure is lined by pia mater, and has its floor covered with medullary matter, which can be traced into the crura cerebelli.

When the membranes are removed, the furrows of both surfaces are found to differ from those of the cerebrum, in having their bases closed with the white neurine, instead of the gray.

The lower surface which is very convex, has been divided by anatomists into as many as five lobes, distinguished as follows: The *anterior* and *internal*, called also the *amygdaloid*, or *tonsillitic;* the *anterior external*, or the *digastric;* the *posterior*, or *semilunar;* the *pneumogastric* lobe, or *flocculus;* the *anterior inferior*, and the *middle lobe*, or *gracilis*. The names of these several lobes define pretty well their location. The tonsil, or anterior internal lobe, is covered by the medulla oblongata, and projects into the fourth ventricle, at its sides and posterior part.

The pneumogastric lobe is near the origin of the eighth pair of nerves—hence its name.

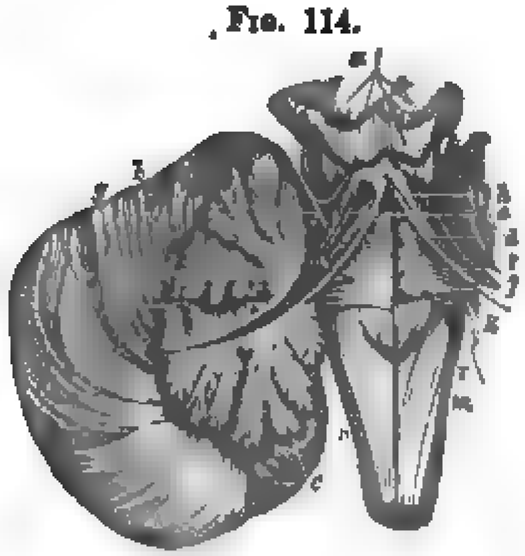
In the median fissure, on the inferior surface, is seen a pyramidal projection, divided into rings transversely, and called the inferior vermiform process, which unites the

hemispheres below. The superior and inferior vermiform processes, though distinguished by different names, are regarded as essentially one and the same lobe, as they are continuous, the one with the other, and have been called the *median lobe*, or *primitive lobe* of the cerebellum.

This primitive lobe is found to be the only portion present in fish and reptiles, while in birds the hemispheres consist simply of small lateral offsets from this central fundamental part.

Upon the inferior vermiform process, three little eminences have received names, the most anterior being called the *nodule;* the middle, the *uvula;* and the posterior, the *pyramid.*

FIG. 114.



The cerebellum consists of cineritious, or gray matter externally, and white or medullary internally. In making a horizontal section, a large white central medullary mass is seen, which can be traced from the one hemisphere to the other. In a vertical section, a beautiful arrangement of the medullary striæ, resembling the branches of a tree, is seen, and hence called *arbor vitæ.* If the vertical incision be made upon the outer third of the hemisphere, there will be noticed in the interior of the white central mass, a small yellowish or gray

FIG. 114 represents the *arbor-vitæ* of the cerebellum. *a* Tubercula quadrigemina. *b* Superior surface of the cerebellum. *c* Inferior surface and arbor vitæ; from the trunk of this latter three fasciculi are traced to the tubercula quadrigemina, the most internal of these fasciculi is, *d* A fibrous layer; on the outside of this is, *e* The next fasciculus, and on the outside of this again is, *f* The third fasciculus. *g* A thin medullary layer passing from the crus cerebelli to the cerebrum. *h* Anterior extremity of fourth ventricle. *i* Middle furrow on the floor of fourth ventricle. *j* Tracts of nervous matter leading to the auditory nerve. *k* Nervous matter presenting a raised appearance on the floor of fourth ventricle. *l* Middle fissure in calamus scriptorius. *m* Corpora-restiformia. *n* A side view of the spinal marrow.

body, called the *corpus dentatum* or *rhomboideum*, or ganglion of the cerebellum. This ganglion receives the greater part of the corpus restiforme, and with the central medullary portion in which it is found, is connected with the medulla oblongata, pons Varolii, and cerebrum. Three processes on each side establish this connection: 1. The inferior process or peduncle, *corpus restiforme*, which extends from the posterior column of the medulla oblongata, to this central portion of the cerebellum. 2. The *anterior peduncle* or *crus cerebelli*, which proceeds from the floor of the horizontal fissure on either side, and passing forward and inward, meets with its fellow of the opposite side to form the anterior layer of the pons or great commissure of the cerebellum, and 3. The *superior peduncle*, or *processus a cerebello ad testes*. These are two white, thick, medullary bands, which are traced from the corpus dentatum of each hemisphere, and ascend above the crura cerebelli, to join the testes. They form part of the lateral boundaries of the fourth ventricle, and are connected to each other by the *valve of Vieussens*, which together act as commissures, both between the cerebrum and cerebellum, as well as between the hemispheres of the cerebellum and the median lobe.

The *fourth ventricle* generally described as belonging to the cerebellum, is rather considered a ventricle of the medulla oblongata. It is situated upon the posterior surface of the medulla oblongata, having the pons in front, the median lobe of the cerebellum behind, and its hemispheres laterally. It appears as a considerable cavity of a quadrilateral shape, about an inch and a half in length, and of nearly the same breadth.

The superior angle of this ventricle leads into the aqueduct of Sylvius; the inferior corresponds with the posterior median fissure of the cord.

On the anterior and inferior wall of this ventricle is a median groove, distinct and sharp, and from its resemblance to a writing pen, has been called *calamus scriptorius*. On either side are white striæ, the *lineæ transversæ* forming the feathers of the pen and being the origin of the auditory

nerve or portio mollis. This cavity is lined in most of its extent by gray neurine.

CEREBRUM OR UPPER BRAIN.

The *Cerebrum*, (Fig. 16,) styled the brain proper, is *situated* within the cranial cavity, occupying the whole of this cavity extending from the vault to the tentorium, by which latter it is separated from the lower brain or cerebellum.

It is about seven times heavier than the cerebellum, weighing from two and a half to three pounds. The brain of man is heavier than that of any other animal. Its *form* is oval, and its average diameters are as follow: the antero posterior about six inches, the transverse in its greatest breadth about five, and the vertical between four and five. It is *divided* into two lateral and symmetrical parts by a deep fissure which runs along the median line, separating the cerebrum in its whole depth, but interrupted by the corpus callosum in the middle. This fissure receives the falx major and the anterior and cerebral arteries and veins, and the two lateral portions thus divided are called *hemispheres.* Each hemisphere is again divided into three lobes, an anterior, middle, and posterior lobe. The anterior or frontal lobes are small and are situated upon the orbitar plates of the frontal bone. The middle or temporal are large and prominent, occupy the middle fossa in the base of the cranium, and are separated from the anterior by the deep fissure of *Sylvius.* This fissure receives the middle cerebral arteries.

The posterior lobes rest upon the tentorium, having but a slight mark of separation from the middle, which however corresponds to the superior ridge of the petrous bone. The *surfaces* of the cerebrum are *superior*, *inferior*, and *lateral.* Its general form has just been stated to be oval, but as it exactly corresponds with the cranial cavity, its shape will vary with the shape of this cavity. The form of the superior surface is convex, corresponding to the concave vault of the cranium—the inferior is flat, adapted

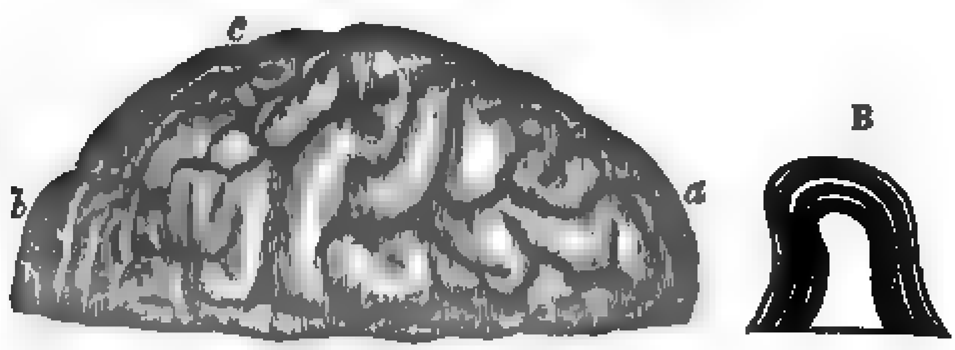
to the base, while the lateral surfaces are also a little flattened. All the surfaces of the cerebrum are marked by distinct eminences, which, from their turnings and resemblance to the intestines, are called *convolutions*, (Fig. 115, A,) while the deep furrows every where seen separating the convolutions are named *anfractuosities*, and range from a quarter to an inch and a half in depth.

The surface of the convolutions presents a smooth and polished appearance, from the presence and covering of the arachnoid membrane. "A convolution is defined to be a convex fold of superficial gray neurine, covered all round to its base by pia mater; and a *sulcus* is a depression or involution between any two or more convolutions, and lined by a continuation of the gray lamina."

The convolutions are very varied, both in their form and number, and though seemingly on first view distinct, yet they really are continuous with and run into each other, though there is nevertheless a close, if not a perfect symmetry between those of opposite sides.

These convolutions constituting the cortical portion, are called by Mr. Solly the *hemispherical ganglia*, and their *structure* does not consist, he says, of a single layer of gray or cortical matter, but according to the microscopic obser-

FIG. 115. A



vations of M. Baillarger, of six layers, three layers of the gray, alternating with three of the white, (Fig. 115, B.) Counting from within, the first is represented as gray, the

FIG. 115, A represents the *convolutions* of one side of the cerebrum. *a* Anterior lobe of cerebrum. *b* Posterior lobe. *c* Middle lobe.

FIG. 115, B represents the six alternate layers of gray and white neurine, composing a convolution of the human brain.

second white, the third gray, the fourth white, the fifth gray, and the sixth white. The outermost or cortical layer, which to the eye is cineritious, is thus seen to be, under the glass, white, and this seems also to accord with the observations of Mr. Grainger, thus reversing the supposed order of the several layers.

In the posterior convolutions the distinction between some of these layers has been frequently seen with the naked eye. The tubular fibres from the hemispheres pass through these layers, and in relation to the convolutions are, according to Mr. Solly, arranged in four different ways, "first, some of them commencing from the convolutions of the anterior, middle, and posterior lobes, pass through the corpora striata, and forming the inferior layer of the crus cerebri, pass through the pons Varolii, so as to form the anterior columns of the spinal cord, the *motor tract;* second, others commencing in the nerves of sensation, after passing through the pons Varolii, and emerging from the substance of the thalamus, terminate in the same convolutions, constituting the *sensory tract;* third, others passing from one side of the brain to the other, and in apposition to the internal surface of all the convolutions, are those fibres which, collected into a mass, form between the hemispheres that wide bridge, the *great transverse commissure* or *corpus callosum,* to be presently described; fourth, in contact with all the convolutions are the fibres of the superior and inferior longitudinal commissures, which connect together those convolutions which are situated on the same side of the mesial line or different portions of the same hemispherical ganglion."

Those fibres going from the anterior and posterior columns of the cord, as from a common centre and spreading out upon the convolutions, are called by Gall and Spurzheim the *diverging fibres.* While those proceeding from the convolutions towards the centre of the brain are named *converging fibres.*

The convolutions are distinguished into *primary* and *secondary.* The primary are those which are found to be

more generally present, and to exist in the inferior animals. They are generally longitudinal in their direction, while the secondary are found to be mostly transverse. One of the most regular of the primary convolutions, is the long curved one situated on the inner or mesial side of each hemisphere above, and separated from the corpus callosum by a narrow furrow, which, from its surrounding the edge of the hemisphere after the manner of a hem, is called the *ourlet* or hem-like convolution; it bends down in front with the corpus callosum, and is lost in the inferior convolutions at the Sylvian fissure, behind; it also follows the corpus callosum, is attached to the posterior convolutions, and can be traced downward and forward into the middle lobe forming the *hippocampus major.*

Another large primary one bounds the fissure of Sylvius, and within this fissure is a cluster of radiated convolutions called the "*island of Reil.*"

The fissure of Sylvius is made a very important point by Mr. Solly, as from one particular spot within it, called the *quadrilateral spot* or *substantia perforata anterior*, all the convolutions are made to arise. At this spot the hemispherical ganglia are first observed as a mere point, and from thence they gradually expand and develop themselves.

Functions of the Convolutions.—The convolutions are regarded as the especial ganglia or instruments of the mind, and comparative anatomy, experiments on living animals, "developmental" anatomy, and pathology are all brought to demonstrate most conclusively that the convolutions constitute the especial cerebral organs of intellectual action—(for further remarks see nervous tissue, under the head of Alphabet of Anatomy.) The cerebrum contains a variety of bodies, which we will examine from the base or below upward, as this is found to be the natural order of development.

The *Crura Cerebri* (Fig. 16) constitute the peduncles of the upper brain, and are situated at the anterior or upper edge of the pons. They are two in number and consist of white, thick, fibrous cords about half an inch in length, round

at the pons, but becoming more transverse as they ascend to the optic thalami, and corpora striata; here they become enlarged and flattened, and enter these latter bodies. As they ascend from the pons they diverge, and are connected by the *intercrural lamina*, or *middle perforated plate.* The optic tracts pass over them internally and in front, and they form the floor of the *iter a tertio ad quartum ventriculum.* Each crus is marked by a groove into two tracts, one of which is continuous with the anterior pyramidal tract through the pons, on to the corpus striatum—the other, which is the larger, corresponds to the olivary body and goes to the thalamus. On cutting the crus it presents, near its centre, a mass of gray matter having rather a darkish appearance, and called *locus niger.* On the inner surface of the crura is seen the attachment of the third pair of nerves. The *size* of the crura, it is believed, bears a proportion to that of the hemispheres into which they expand.

The *Corpora mammillaria*, or *albicantia*, (Fig. 16,) are two small white bodies, about the size of a pea, *situated* upon the inner surfaces of the crura at their anterior extremity. Their *structure* is white externally, and gray or cineritious within. Their relation is with the anterior pillars of the fornix which terminate in them. They have the tuber cinereum in front, and partly assist in closing the third ventricle. These with the locus niger, are regarded as ganglionic.

The *Tuber Cinereum* (also called *pons Tarini*) is a soft, gray body, on the under surface of the crura cerebri, in front of the albicantia, and behind the optic commissures. It forms the floor of the third ventricle.

The *Infundibulum* is a conical tubular body of gray matter, proceeding from the centre of the tuber cinereum, and descending to the pituitary gland in the sella turcica. Its upper part opens into the third ventricle—its lower part forms the apex, and by some is said to be closed—though Meckel asserts it is open through its whole extent.

The *Pituitary gland* is situated in the sella turcica of the sphenoid bone, between the dura mater and tunica arach-

noidea, by which membranes it is firmly retained in its place, and has a very slight connection with the brain. It is *oval* transversely, and presents the appearance of two lobes, of which the anterior is the larger. It is a firm body consisting of cineritious matter externally, and medullary within. On either side a depression is observed connecting it, by two small canals, with the infundibulum. Though called a gland, yet there is nothing in its structure or function, so far as we are acquainted, by which it can be placed among the glands.

Tubercula Quadrigemina.—Dissection.—Having the base of the brain uppermost, draw the cerebellum forward and remove the pia mater. These are four beautifully white bodies, situated above the crura cerebri, and behind are connected with the *thalami.* The superior are called the *nates;* the inferior, the *testes.* It is the nates which are connected with the thalami. The testes are united to the cerebellum by two thin, white laminæ, called the *processus a cerebello ad testes,* which diverge to the cerebellum, through and forming part of its crus. Between these processes is seen a white layer of medullary matter extending from one side to the other, forming the

FIG. 116.

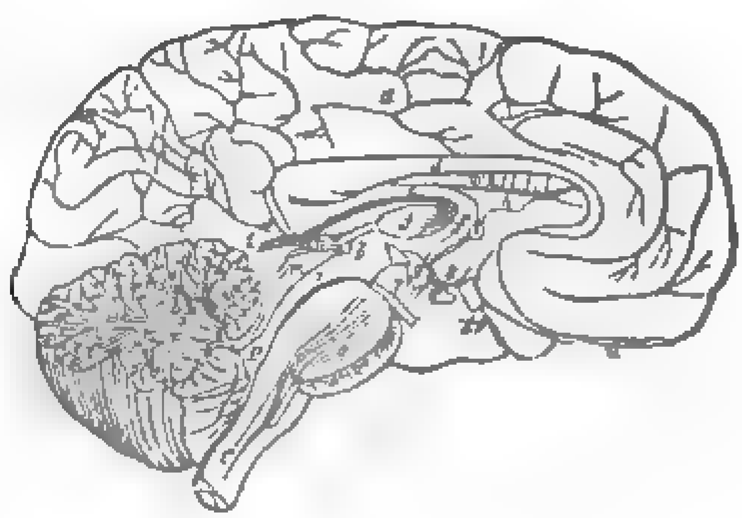


FIG. 116 represents a longitudinal section of the Brain, the incision being made along the middle line between the two hemispheres of the cerebrum. *a* Inner surface of the left hemisphere. *b* Section of the cerebellum, displaying the arbor vitæ. *c* Medulla oblongata. *d* Corpus callosum. *e* Fornix. *f* One of the crura of the fornix. *g* One of the corpora albicantia. *h* Septum lucidum. *i* Velum interpositum. *j* Division of the middle commissure of the third ventricle. *k* Division of anterior commissure. *l* Division of posterior commissure. *m* Corpora quadrigemina. *n* Pineal gland. *o* Aqueduct of Sylvius, or iter a tertio ad quartum ventriculum. *p* Fourth ventricle. *q* Pons Varolii. *r* Crus cerebri *s* Tuber cinereum. *t* One of the optic nerves. *u* Left olfactory nerve.

roof of the fourth ventricle, and called the *valve* of *Vieussens.*

This valve is streaked with gray matter—is covered by the superior vermiform process, and has the fourth pair of nerves arising from it. A tube or canal is traced beneath the tubercula quadrigemina, leading from the third to the fourth ventricle, beneath the valve of Vieussens, called the *aqueduct of Sylvius.* The four tubercles, though separated by a transverse and vertical fissure, have but one common base. They are covered by a vascular membrane—the *velum interpositum.* The structure of these bodies is white without, and gray within.

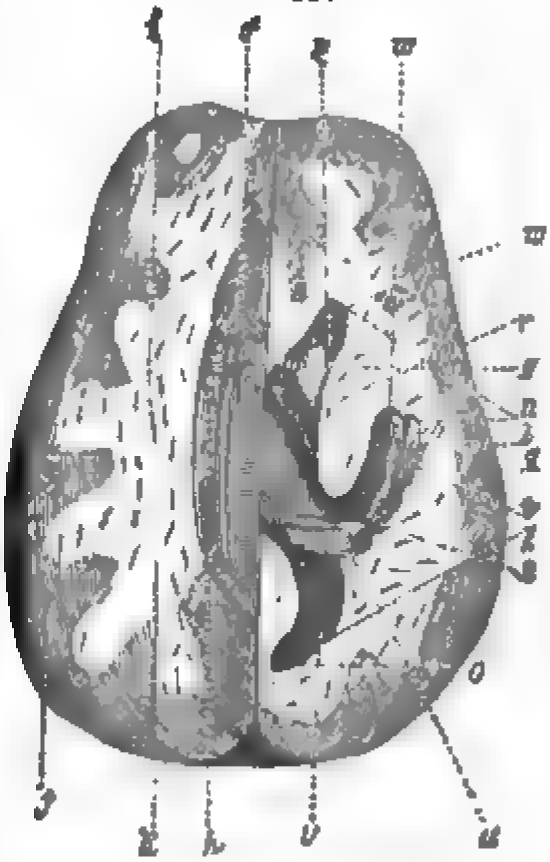
Only two of these tubercula are seen in fish and reptiles, and are viewed as the optic lobes, or the organs which receive and recognize the impressions of light, color, &c.

The *pineal gland,* (Fig. 116,) is *situated* upon the nates and is surrounded by the velum interpositum, a reflection of pia mater. It is an oblong, reddish body, composed of cineritious matter, and containing calcareous particles or gritty matter called *acervulus,* which on analysis is found to consist principally of phosphate and carbonate of lime. The posterior part of this gland is soft and called *conarium.* It is united to the thalami by two delicate processes, the *pedunculi,* which proceed forward on the inner margins of the thalami, and join the descending pillars of the fornix. A variety of opinions have been indulged in reference to the use of this gland. Des Cartes believed it to be the seat of the soul, and Majendie that it closed the aqueduct of Sylvius, and thus cut off the communication between the third and fourth ventricles, while another and more plausible view makes it a commissural body.

Thalami optici, or *posterior ganglia,* (Fig. 117.)—These ganglia are very prominent in the interior of the brain. They are situated upon the upper surface of the crura cerebri, and can be most readily got at by separating the hemispheres, and turning aside the corpus callosum and fornix, which cover them. The thalami are large, oval bodies, placed side by side in the longitudinal direction,

about an inch and a half long, and three quarters of an inch in breadth and depth. They are convex superiorly and internally, and form the floor of the lateral ventricles. They are separated in front by the tænia semi-circularis, from the corpora striata, and are connected behind to the tubercula quadrigemina; on the posterior and inferior free portion two rounded eminences are observed, of a grayish color, called *corpus geniculatum, externum* and *internum*. The optic nerves are connected with these eminences. A third tubercle is spoken of, situated above the corpora geniculata, and called the *tuberculum posterius superius*.

FIG. 117.



The *structure* of the thalami is medullary without, and a mixture of white and gray matter within, forming a plexiform arrangement. The fibres are traced to the olivary or sentient tract with which they are continuous, also to the testes by the processes a cerebello ad testes, and to the posterior and upper part of the crura cerebri. From their external surface these fibres expand into the hemispheres. On their internal and upper surface is seen the long peduncle of the pineal gland, and at their anterior part they are connected to the descending crura of the fornix, to the tuber cinereum, and corpora albicantia.

These thalami have been called, as stated, the *great pos-*

FIG. 117 represents a horizontal section of the brain. *f* Corpus callosum. *g* Raphe in its centre. *h* Lineæ transversæ. *i* Centrum ovale of Vieussens. *j* Cortical portion of cerebrum. *k* Medullary portion of cerebrum. *l* Lateral ventricle. *m n o* Its anterior, middle, and posterior cornua. *p* Corpus striatum. *q* Thalami nervi optici. *r* Linea semi-circularis. *s* Hippocampes major. *t* Pes hippocampi. *u* Tænia hippocampi. *v* Hippocampus minor. *w* Plexus choroides.

terior cerebral ganglia—are considered as the *centres* of *sensation*, and have been observed to bear a proportion in size to the posterior lobes of the cerebrum. Between the thalami a cavity is noticed, called the *third ventricle*. This cavity has the fornix above and in front—the tuber cinereum below, and the tubercula quadrigemina behind. At its anterior part it opens into the infundibulum, and in its posterior portion it communicates with the fourth ventricle by the aqueduct of Sylvius.

This cavity is closed by a soft layer of cineritious matter called the *commissura mollis*, which connects the two internal surfaces of the thalami together.

In front of this commissure is the *foramen commune anterius*, leading to the pituitary gland; and behind is the *foramen commune posterius*, leading to the fourth ventricle. The *posterior commissure* is behind the third ventricle, and connects the thalami at this point. It is a short, white, round cord, extending transversely. There is another white, round cord, called the *anterior commissure*, which belongs more properly to the next bodies we have to examine.

Corpora Striata, (Fig. 117.)—These bodies, so called from their striated appearance when cut into, are also named *anterior* or *superior ganglia* of the cerebrum. Their *situation* is in front of the thalami; their *shape* is pyraform, having their smaller ends looking backward and outward, and enclosing the thalami—while their larger extremities converge and touch each other in front. They are about two and a half inches long, and help to form the floor of the lateral ventricles.

Their *structure* is soft, vascular, and cineritious on their surface. Internally the gray matter is seen intermixed with the white medullary striæ, or fasciculi. These fasciculi can be traced from the anterior or motor portion of each crus, and still further back from the anterior rods of the spinal cord; after passing through the corpora striata, they expand principally into the anterior and middle lobes of the hemispheres, to which they bear a

relative proportion. They are regarded as the ganglia, or *centres of motion*, seeing their fibres come mostly from the motor tract.

They are separated from the thalami by the *tænia semicircularis*, which is a narrow medullary band, dividing these two sets of ganglia from each other, and extending from the *corpus geniculatum externum*, upon the optic thalamus, to the *descending* crus of the *fornix*. Its *function* is considered commissural.

The *Lateral Ventricles* (Fig. 117) are cavities occupying the centre of the brain. Each of them has three cornua—the *anterior* passing forward in the anterior lobe; the *middle* winding downward, forward, and outward into the middle lobe; and the third, or *posterior*, passing back into the posterior lobe. These ventricles are large, horizontal, but very irregular cavities, bounded above by the *corpus callosum*, having for their floor the *corpora striata*, *thalami optici*, and *fornix*; and separated from each other by the *septum lucidum*.

The anterior cornu presents nothing of any great importance, except the corpus striatum, already noticed. In the middle cornu is seen the *hippocampus major*, or *cornu ammonis*, a large, winding, and beautifully white body—convex externally, and concave internally. It follows the whole extent of this cavity, occupying its floor, and terminates in some tubercles called *pes hippocampi*. This body is the continuation of the primary convolution, called "*ourlet*." Its internal edge is loose and concave, presenting a narrow white band, called *tænia hippocampi*, or *corpus fimbriatum*. Beneath the tænia a narrow cineritious line is seen, named from its serrated appearance, *corpus denticulatum* or *fascia dentata*. In the posterior cornua a smaller eminence is observed, the *hippocampus minor*, white externally and gray within.

Fornix.—This body, (Fig. 116,) so called from its arch or vault-like appearance, is triangular in its shape and forms the roof of the third ventricle. It is *situated* beneath the corpus callosum and septum lucidum, next to be examined.

The fornix is a white, medullary body, convex above, larger behind, where it receives three roots to the *hippocampus major*, *minor*, and *tænia hippocampi*. The union of these roots constitutes the *body* of the fornix, which, arching over the third ventricle and resting upon the thalami, proceeds forward to terminate in two white cords or pillars called the *anterior crura* of the fornix. These descend, adhering to the thalami in front, and terminating in the *corpora mammillaria*, or *albicantia*. The upper surface of the fornix is free and smooth; the lower presents several oblique lines called *lyra*, or *corpus psalloides*. Its *structure* is medullary and fibrous, and its *function* is considered *commissural*, forming extensive and distinct connections with different parts. Its posterior crura are related to the *middle* and *posterior lobes;* its body is connected with the *septum lucidum*, and *corpus callosum;* and its anterior crura join the *thalami*, the *peduncles of the pineal gland*, the *tænia semicirculares*, the *corpora albicantia*, and the *tuber cinereum*.

On the edges of the fornix is seen a fold of membrane loaded with a mass of blood-vessels—one on each side, and formed of a reflection of pia mater, called *plexus choroides*. This plexus enters the middle crura at the great central fissure between the *optic* thalami and tænia hippocampi; it is seen as a loose, floating body, following the course of the hippocampus major, covering the thalami, and proceeding forward to the anterior crura of the *fornix*. Behind the foramen commune anterius, they both unite to form the vein of Galen, *vena Galeni*, which runs back along the middle of the *velum interpositum* to the straight sinus.

This *Velum Interpositum* (Fig. 116) is situated on the under surface of the fornix. It consists of pia mater, and prevents any communication between the third and lateral ventricles, except at its anterior part, where is seen an opening, called the *foramen of Monro*, beneath the anterior crura of the fornix. This membrane goes back to the pineal gland, and so envelops it, that there is danger of removing this gland along with it, unless great care be

taken. At this point, beneath the vein of Galen, the *arachnoid canal*, or canal of Bichat, is seen.

Corpus Callosum, (Figs. 116, 117.)—By separating widely the hemispheres, this body is seen presenting a brilliant white appearance, and quadrilateral shape. It occupies the centre of the brain; its greatest length, which is about three or four inches, being in the longitudinal direction. It forms the roof of the lateral ventricles, and covers the fornix. Its upper surface is white, convex, and marked with two or three longitudinal lines called the *raphe*, from which transverse lines are seen on either side. Its anterior portion is round and bends downward into the anterior lobes and base of the brain. Its posterior end is thick, round, and continuous with the fornix and hippocampi; externally, portions of it curve downwards and join the thalami and corpora striata. The corpus callosum connects the two hemispheres of the cerebrum, and is called the *great cerebral commissure*.

The *Septum Lucidum* (Fig. 116) is the membranous partition between the lateral ventricles, and extends from the median surface of the corpus callosum to the fornix. It is described as consisting of four laminæ. The first comes from the lateral ventricle; the second consists of gray matter; the third is a white, fibrous layer; and the fourth is a very delicate layer containing a cavity called the *fifth ventricle*. It is generally regarded as being composed of two laminæ, between which is the fifth ventricle; and each of these is capable of being divided into two—the outer layer being cineritious, the inner medullary. This ventricle, in the natural state, is supposed to be closed; but it is thought by others to form a portion of the third ventricle, as in the early periods of uterine life. *Tiedenman* found it to communicate with the latter cavity. The *function* of the septum lucidum is regarded as commissural.

On making a horizontal section of one of the hemispheres of the cerebrum, in the centre there is observed a mass of white, fibrous, medullary matter, surrounded by a wavy line of gray. This central appearance is called the *centrum*

ovale minus. The other hemisphere, cut in the same way, presents a similar view; and the two together receive the name of *centrum ovale majus*, which is nothing more than the white central mass of medullary matter, surrounded by gray or cineritious substance. (Fig. 117.)

NERVES OF THE ENCEPHALON. (Fig. 16.)

The nerves of the encephalon are nine pair, according to the old nomenclature, and eleven or twelve pair according to the more modern. The additional number is arrived at by making two out of the seventh and three out of the eighth pair.

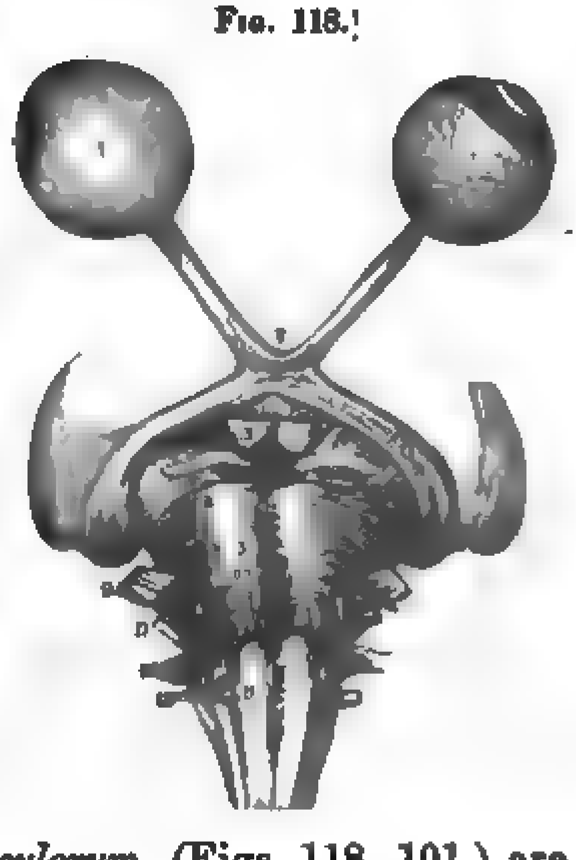
M. Cruveilhier remarks it is more philosophical to examine the nerves of the brain from behind forward, but as it is more convenient in the removal of the brain, to study these nerves then, we shall adopt the usual plan, and describe them from before backward, and in their numerical order.

First Pair, or *Olfactory Nerves*, (Fig. 118.)—These are the nerves of smell, and are *situated* on the lower surface of the anterior lobes of the cerebrum. Each arises by three filaments, one of which is *external* from the fissure of Sylvius, long and white; the second *internal* from the corpus callosum, and the middle, gray, from the posterior convolution of the anterior lobe. The three unite to form a soft, gray, triangular nerve, having a bulbous expansion, which is lodged between the convolutions, where it is protected and covered by the arachnoid membrane. Each bulb rests on the *cribriform plate* of the *ethmoid bone*, on either side of the *crista-galli*, whence proceed numerous filaments through the various foramina in this plate to the mucous membrane of the nose. These divide into two sets, an internal, and an external, the former going to the septum, the latter to the upper and middle spongy bones. These nerves differ from all others in their *shape*, which is triangular, and in their *structure*, which is very soft, some fibres being white, others gray, and in not being surrounded by the arachnoid. Their bulbs are called by Mr. Solly the *olfactory ganglia*.

Second Pair, or *Optic*.—These are the nerves of sight,

(Fig. 118;) they are large, and arise from the *nates* of the *tubercula quadrigemina*, and the *corpora geniculata externa*, upon the optic thalami. From these origins, on either side, is formed a soft, flat band, the *tractus opticus*, which winds round the crus cerebri, and then converges to meet its fellow of the opposite side in the *optic commissure* or *chiasma* before the sella turcica; here it is connected by filaments to the tuber cinereum, and the point is not settled whether these nerves at this junction decussate or simply unite, or whether both conditions exist. The latter opinion seems the most tenable, that one portion of the fibres which compose the optic nerves, at their commissure, cross each other and go to the opposite eye, while the other portion simply unites with its fellow and then passes to the eye of the same side. Anterior to the junction, the nerve becomes round and passes forward on the inside of the carotid, and above the ophthalmic artery to the *optic foramen* through which it passes. On entering the orbit it is surrounded by a process of dura mater, which divides into two portions, the one being continuous with the periosteum of the orbit, the other with the sclerotic coat of the eye. The nerve then enters the back part of the eye through the sclerotic and choroid coats to terminate in the retina.

Fig. 118.



Third Pair, or *Motores Oculorum*, (Figs. 118, 101,) are

Fig. 118 represents the second pair or nerves of sight, the Optic. 1 1 Ball of the eye, the right one has the sclerotic and cervical coats removed to show the retina. 2 Chiasm of optic nerves. 3 Corpora albicantia. 4 Infundibulum. 5 Pons Varolii. 6 Medulla oblongata. 7 Third pair motores oculi. 8 Fourth pair pathetici. 9 Fifth pair trigemini. 10 Sixth pair motores externi. 11 Facial and auditory. 12 Eighth pair pneumogastric, spinal accessory, and glosso-pharyngeal. 13 Ninth pair hypo-glossal.

nerves of motion, and arise each from the inner side of the crus cerebri, close to the pons, its fibres being traced to the locus niger in the crus. These nerves penetrate the dura mater at the posterior clinoid process, and proceed forward along the outer wall of the cavernous sinus to the foramen lacerum superius, through which they pass, and then dividing into two branches, supply five of the seven muscles contained in the orbit.

Fourth Pair of Nerves, Pathetici or *Trochleares*, (Fig. 118.) These are the smallest nerves of the brain, not larger than an ordinary strand of cotton, and arise each by two or three filaments from the *valve of Vieussens*, and *processus a cerebello ad testem;* they are very delicate and easily broken, and pursue a long course on the outer margin of the pons, between the cerebrum and cerebellum, to the posterior clinoid process, where they enter a canal of the dura mater, then proceed along the external wall of the cavernous sinus, at first below the third, then above all the nerves at this point, to the *foramen lacerum superius* or *sphenoidal* fissure, through which the last pass to be distributed solely to the superior oblique muscles of the eye.

Fifth Pair, Trifacial or *Trigemini*, (Figs. 118, 74.)—These are compound nerves, having filaments both of sensation and motion, hence they have been called the cranial-spinal nerves. They are the largest of the cerebral nerves, and, according to Dr. Alcock, arise by two roots from an eminence, on a longitudinal tract of yellowish matter in front of the floor of the fourth ventricle, which divides inferiorly into two fasciculi, traceable downward to the spinal cord, the one going to the anterior column, the other to the posterior. The two roots having this origin, emerge on the side of the pons Varolii, where it is continuous with the crus cerebelli. Here they are separated by a narrow, transverse fasciculus. The union of the two constitutes the fifth nerve, which consists of from 70 to 100 filaments bound together by pia mater. The nerve passes forward in an oval opening or canal in the dura mater, formed by the separation of the two layers of this membrane, and then expands

in the middle fossa, on the anterior cerebral surface of the petrous bone, into the *Casserian ganglion.* This ganglion is of a semilunar shape, and presents, on removing the dura mater, a dark and flat appearance, with its filaments matted or having the plexiform arrangement. On raising this ganglion, the smaller motor or anterior root will be seen to pass on its under surface without any adhesion. It is easily separated and may be traced on to the inferior maxillary nerve, with which it unites.

Three large branches proceed from this ganglion, the *ophthalmic*, the *superior*, and the *inferior maxillary nerves.* The first enters the orbit through the foramen lacerum superius, and supplies the eye and its appendages with common feeling or general sensibility; the second or superior maxillary is distributed to the upper jaw and face, supplying these parts also with sentient nerves; the third or inferior maxillary nerve is the largest branch and passes through the foramen ovale. Its motor portion supplies the muscles of mastication, as the temporal, masseter, pterygoid, and buccinator, while the sensitive goes to the lower jaw, tongue, chin, lips, &c.

Sixth Pair, Motores Externi or *Abducentes Oculi*, (Fig. 118.) This pair is of a size between the third and fourth. Each nerve arises from the superior extremity of the *corpus pyramidale*, close to the pons, passes forward to the body of the sphenoid bone, where it penetrates the dura mater, courses the cavernous sinus on the outside of the carotid, enters the orbit through the foramen lacerum superius, and goes to the *rectus externus muscle.* The root of the nerve has been traced through the corpora pyramidalia into the gray matter of the olivary bodies.

Seventh Pair, Portio Dura and *Portio Mollis*, (Figs. 16, 109.)—This pair is regarded by some as two distinct nerves, and so divided. The *portio dura* is the smaller of the two, and arises from the upper part of the *medulla oblongata* close to the lower part and side of the pons, below the crus cerebelli and in front of the corpus restiforme, into the gray neurine of which its fibres can be traced. It is called the *facial*

nerve, and, according to Mr. Bell, has its origin from the respiratory tract. It enters the *foramen auditorium internum*, passes along the *aqueduct of Fallopius*, and emerges at the *stylo-mastoid foramen*, from whence it is distributed to the muscles of expression.

The *portio mollis*, or *auditory* nerve, is the larger of the two, and the most posterior. It arises from the side of the *calamus scriptorius*, the floor of the *fourth ventricle*, and the *corpus restiforme*, by several filaments which form a very soft, white cord; then unites with the portio dura, and enters along with it, the internal auditory foramen, from which, at the base of this canal, it separates and goes to supply the internal ear, as the cochlea, semicircular canals, &c. This nerve is the nerve of hearing.

The *Eighth Pair* consists of the *Glosso Pharyngeal*, (Figs. 91, 118,) *Pneumogastric*, or *par vagum*, and the *Spinal accessory*.

The *glosso pharyngeal* arises, by four or six filaments, from the fissure between the olivary and restiform bodies, or from the respiratory tract; these unite into a small nerve which joins the *par vagum*. The *par vagum*, or *pneumogastric*, arises below the last, in the same groove between the *corpus olivare* and *corpus restiforme*, by ten or fifteen filaments, which, uniting together, form a larger nerve than the glosso-pharyngeal; the two now proceed together to the foramen lacerum posterius, where they are joined by the third portion—the *spinal accessory*. This latter nerve arises low in the neck—as low as the fourth or fifth vertebra, and occasionally as low as the seventh cervical, by several filaments from the respiratory tract on the sides of the medulla spinalis, between the roots of the anterior and posterior spinal nerves; it ascends behind the ligamentum denticulatum, receiving filaments from the spinal nerves, in its ascent, and after entering the foramen magnus, proceeds to the foramen lacerum posterius, where it joins the other portions of the eighth pair. They all pass through the foramen lacerum posterius, anterior to the jugular vein, and then each proceeds to its peculiar

place of distribution—the glosso pharyngeal to the tongue and pharynx, the pneumogastric to the lungs and stomach, and the spinal accessory to the muscles on the side of the neck.

The several portions of the eighth pair, at the foramen lacerum posterius, have each a distinct sheath of dura mater; though the par vagum and spinal accessory, having been seen occupying the same canal, have been compared to a spinal nerve, the latter representing the anterior or motor root, the former the posterior or sentient.

Ninth Pair, Lingual or *Hypoglossal*, (Figs. 118, 91.)—These belong to the tongue, and are motor nerves. They arise by a number of filaments, which vary from four to ten, from between the corpus pyramidale and olivare. These filaments unite into a single trunk, one for each side, and receiving a sheath of the dura mater, pass through the anterior condyloid foramen of the occipital bone, to be distributed principally to the tongue.

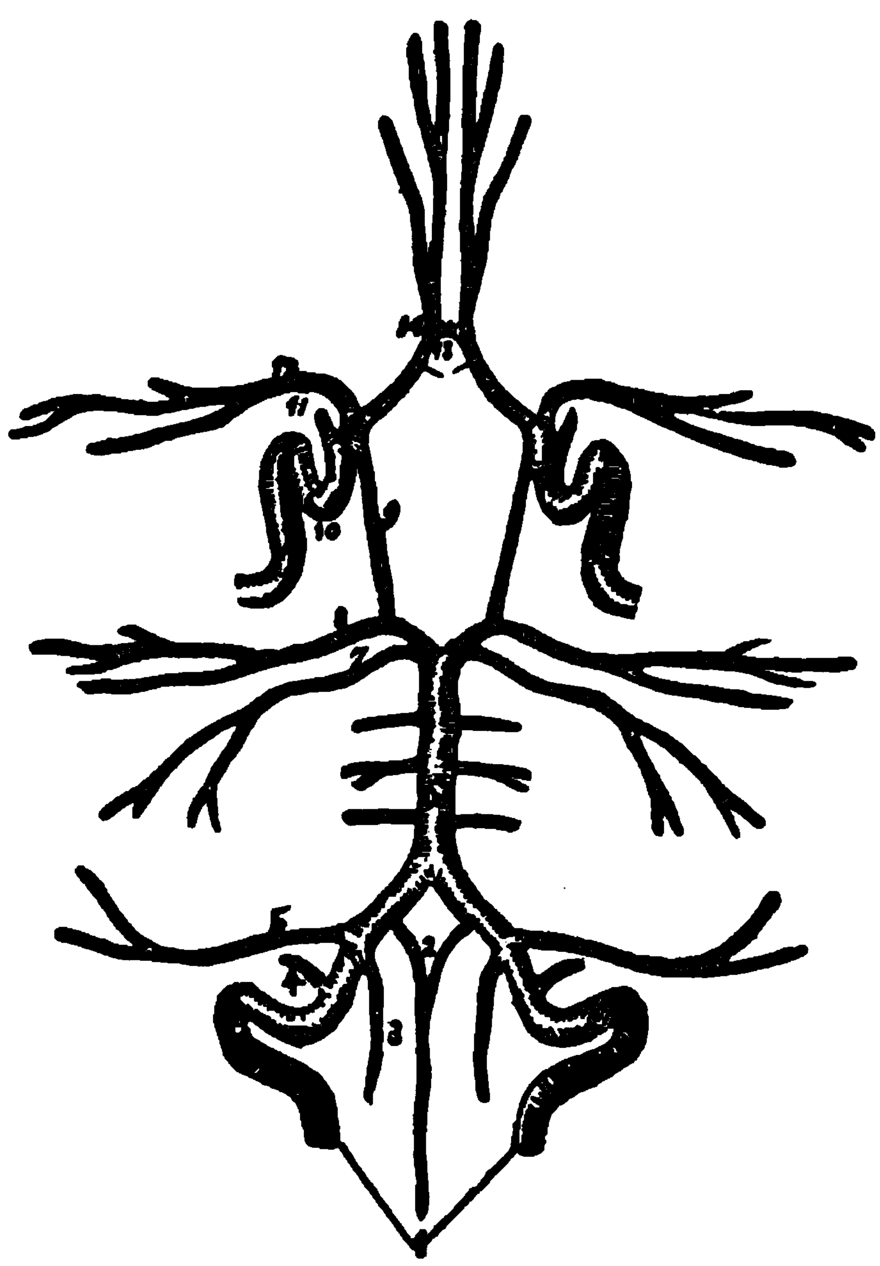
BLOOD-VESSELS OF THE BRAIN.

The *internal carotid* and *vertebral arteries* are the great sources of supply of blood to the brain. Each internal carotid gets into the cavity of the cranium, by a tortuous course through the carotid canal of the temporal bone. On leaving this canal it ascends through the cavernous sinus, and at the anterior clinoid process it gives off the ophthalmic artery which goes to the eye and its appendages. At this point the carotid gives off, in its course, small branches to the cavernous sinus and dura mater. The remainder of its branches supply the brain, and consist of the *anterior*, *middle*, and *posterior* cerebral.

The *anterior branch*, *anterior cerebri*, called also the *artery of the corpus callosum*, proceeds forward and inward, and after uniting with its fellow by a transverse branch, (the *anterior communicating artery*,) ascends upon the upper surface of the corpus callosum, supplying this body and the inner surface of the hemispheres. The *middle artery* is the largest, and goes outward to the fissure of Sylvius, supplying the anterior and middle lobes of the cerebrum, and ascend-

ing upon the upper surface of the hemispheres to anastomose with the anterior and posterior cerebral arteries. The *posterior branch* passes backward to join the posterior cerebral artery, forming the side of the circle of Willis, and is called the *posterior communicating artery.*

FIG. 119.



The internal carotid sometimes sends off a branch called the *arteria choroidea,* which passes into the middle cornu of the lateral ventricle, and is distributed upon the plexus choroides.

The *vertebral arteries* arise from the subclavian, sometimes from the aorta. They ascend in a straight line through the series of foramina in the transverse processes of the six upper cervical vertebræ, anterior to the cervical nerves. At the second vertebra these arteries take a direction *outward,* and then again ascend vertically through the foramen in the transverse process of the atlas. After this they take a horizontal direction backward, round the superior oblique process of the atlas in a depression at its back part, and then ascend upward and inward through the foramen magnum, into the cranium, penetrating the dura mater a

FIG. 119 represents the Circle of Willis, surrounding the Sella Turcica. 1 Vertebral arteries. 2 The two anterior spinal branches, forming a single trunk. 3 Posterior spinal artery. 4 Posterior meningeal. 5 Inferior cerebellar. 6 Basilar artery. 7 Superior cerebellar artery. 8 Posterior cerebral. 9 Posterior communicating branch of internal carotid. 10 Internal carotid. 11 Ophthalmic artery. 12 Middle and cerebral artery. 13 Anterior cerebral arteries. 14 Anterior communicating artery.

little above the condyles of the occipital bone. In the cranium they are seen on the under surface of the medulla oblongata, approaching each other till they reach the posterior part of the pons. At this point they unite into a common trunk called the *basilar artery*.

The vertebral arteries in their course send off small arteries to the membranes of the spinal marrow and adjacent muscles, and at their superior extremity they give off three important branches, the *anterior* and *posterior spinal*, and *inferior cerebellar arteries*. The anterior and posterior spinal, as elsewhere stated, are two long and delicate branches, the one in front, the other behind the spinal cord, running the entire length of this organ and giving off branches to the several spinal nerves.

The *basilar artery*, formed by the junction of the two vertebrals, is situated on the median line of the pons, sending many fine branches into its substance, and at its upper edge giving off four branches, two to each side, the *superior cerebellar* and *posterior cerebral arteries*. The former wind round the crura cerebri, send a branch with the seventh pair of nerves into the internal auditory foramen and finally distribute themselves upon the upper surface of the cerebellum, anastomosing with the inferior cerebellar arteries.

The *posterior cerebral* are much larger branches, and separated from the latter at their origin by the third pair of nerves. They receive the posterior communicating branch of the carotids, wind round the crura cerebri, to which branches are supplied, and are finally spent upon the posterior lobes, anastomosing with the middle and anterior arteries of the cerebrum.

The *circle of Willis* will now be understood to be formed in front and laterally by the internal carotids and their posterior communicating branches, while the back part of the circle comes from the basilar. This circle surrounds the commissure of the optic nerve.

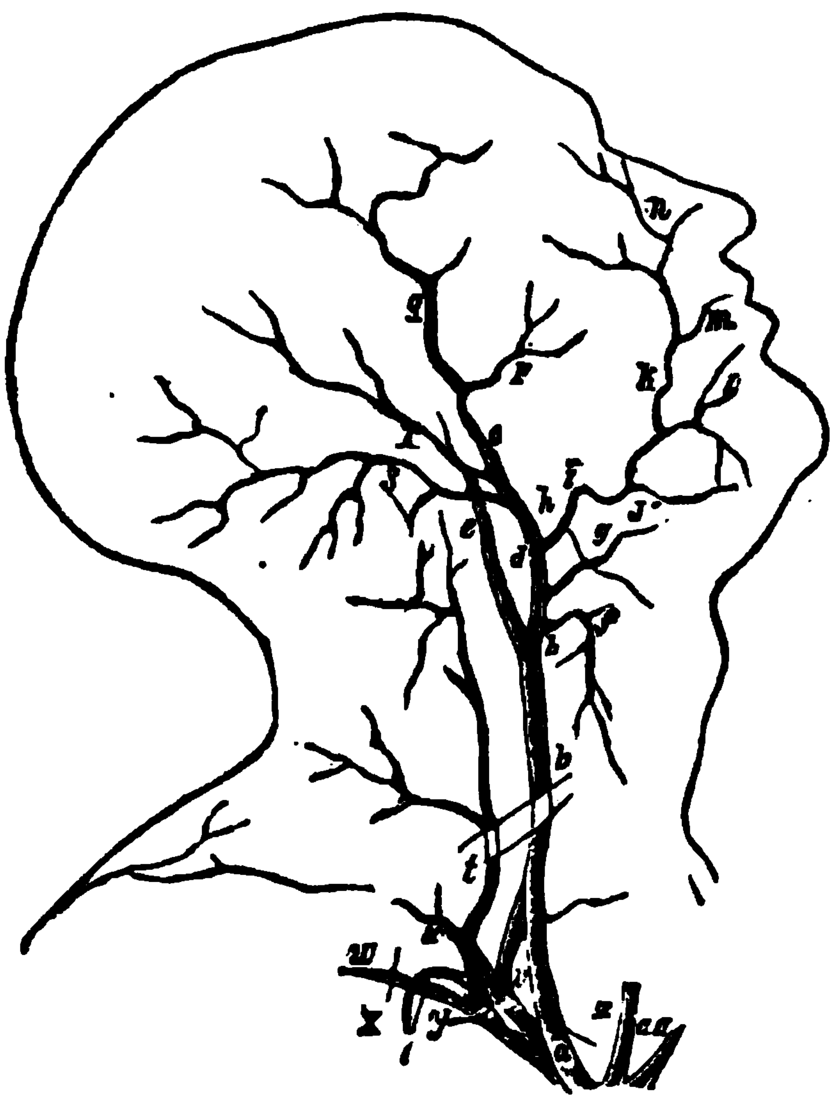
The veins of the brain have already been noticed with the sinuses of the dura mater.

SECTION IV.

BLOOD-VESSELS OF THE HEAD IN THEIR NUMERICAL ORDER.

The *external* and *internal carotid*, and *vertebral arteries*, are the great sources which supply the head with blood.

FIG. 120.



The *external* and *internal carotids* arise from the common carotids in the neck, opposite to the space between the os-hyoides and the thyroid cartilage. The external carotid ascends from this origin to the neck of the lower jaw, adjacent to the meatus auditorius externus. It is crossed near its origin by the lingual nerve; also by the digastric and stylo-hyoid muscles, and is covered in front by the platysma, and superficial fascia. Its upper extremity is imbedded in the substance of the parotid gland. It gives off the following branches:

SUPERIOR THYROID.

LINGUAL.

Hyoid.
Dorsalis linguæ.
Sublingual.
Ranine, which is the continued trunk of lingual.

FACIAL.

Inferior palatine.
Submaxillary.
Sub-mental.
Inferior labial.
Inferior coronary.
Superior coronary.

FIG. 120 represents the branches of the External Corotid Artery. *a* Arteria-innominata. *b* Common carotid. *c* Bifurcation of common carotid. *d* External carotid. *e* Internal carotid artery. *f* Superior thyroid. *g* Lingual. *h i* Facial. *j* Submental. *k* Continuation of facial. *l m* Inferior and superior coronary arteries. *n* Nasal or angular branch. *o* External carotid continued. *p* Internal maxillary. *q* Temporal. *r* Posterior auricular. *s* Occipital artery.

Lateralis nasi.
Angularis, or terminating branch.

INFERIOR OR ASCENDING PHARYNGEAL.

Pharyngeal branches.
Posterior meningeal.

OCCIPITAL.

Inferior meningeal.
Princeps cervicis.

POSTERIOR AURICULAR.

Stylo-mastoid.

TEMPORAL.

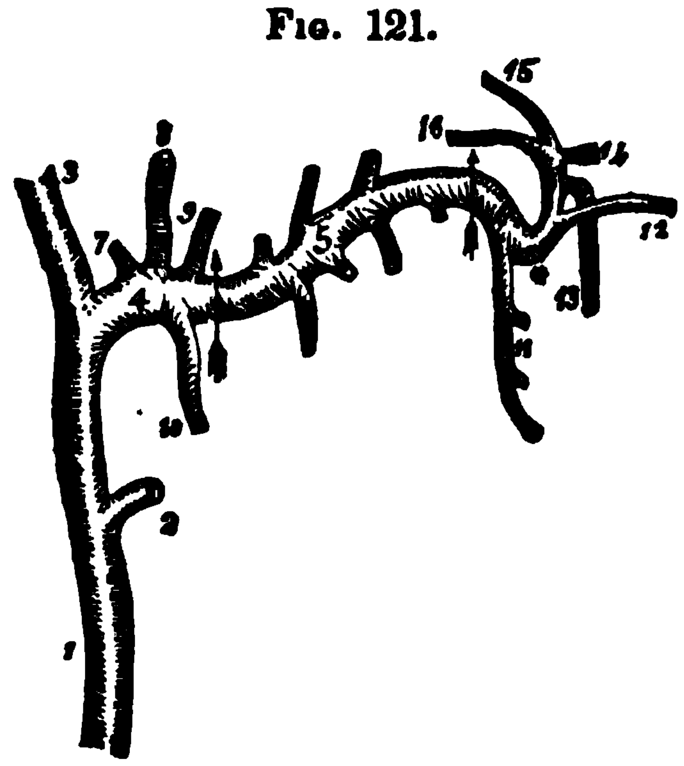
Anterior auricular.
Transverse facial.
Middle temporal.
Anterior temporal.
Posterior temporal.

INTERNAL MAXILLARY, (Fig. 121.)

Tympanic branch.
Greater or middle meningeal.
Less meningeal.
Inferior dental, or maxillary.
Posterior deep temporal.
Masseteric.
Pterygoid.
Buccal.
Anterior deep temporal.
Superior dental, or alveolar.
Inferior orbitar.
Superior palatine.
Superior pharyngeal.
Spheno-palatine.

The *superior thyroid* is the first branch of the external carotid, and descends to be distributed principally to the thyroid gland. As it is connected with the neck, we defer any further notice of it till that part of the body comes under examination.

FIG. 121.



The *lingual artery* arises just above the latter, and passes inward above the os-hyoides to the base of the tongue. It is covered at its origin by the *digastric* and *stylo-hyoid* muscles, and at the base of the tongue lies between the *hyo-glossi* and *genio-hyo-glossi*, whence it runs forward to the tip.

FIG. 121 represents the branches of the Internal Maxillary Artery. 1 External carotid. 2 Trunk of transverse facial. 3 4 Terminal branches of external carotid. 3 The temporal. 4 Internal maxillary artery—the first part of its course extending to the first arrow. 5 Pterygoid, or second part of its course between the two arrows. 6 Pterygo maxillary, or terminating portion. The branches belonging to these three divisions are, 7 A tympanic branch. 8 Greater meningeal. 9 Lesser meningeal. 10 Inferior dental. Th second division are muscular branches, as the temporal, masseteric, pterygoid and buccal. 11 Superior dental. 12 Infra orbital. 13 Posterior palatine. 14 Spheno palatine, or nasal. 15 Pterygo palatine. 16 Pterygoid, or Vidian.

The *hyoid* is the first branch and supplies the parts above the os-hyoides.

The *dorsalis linguæ*, the second branch, ascends to the dorsum of the tongue supplying the base of this organ, the *fauces* and the *velum*.

The *sublingual* is the third branch, and sends branches to the sublingual gland, the mylo-hyoid muscle, and the mucous membrane; this sometimes comes from the facial.

The *canine* forms the continued trunk of the lingual, and advances forward between the *genio hyo-glossus* and *lingualis*, to the tip of the tongue, sending off branches on either side as it proceeds forward.

The *facial artery* arises a few lines above the lingual, opposite the os-hyoides, ascends behind the *digastric* muscle to the base of the lower-jaw, a little anterior to its angle, above and closely connected with the sub-maxillary gland. It mounts over the lower jaw anterior to the *masseter muscle*, then ascends to the angle of the mouth, and still upward to the angle of the eye, where it terminates by anastomosing with the *ophthalmic* branch of the *internal carotid*.

Its branches are:

The *inferior palatine* which ascends by the side of the pharynx, between the stylo-glossus and stylo-pharyngeus muscles, to supply the tonsils and velum, and anastomoses with the superior palatine from the internal maxillary.

The *submaxillary* sends off several branches to the submaxillary and adjacent lymphatic glands.

The *sub-mental* comes off at the base of the lower jaw and proceeds forward upon the mylo-hyoid muscle, above the anterior belly of the digastric to the chin, supplying these muscles and anastomosing with its fellow of the opposite side, and with the inferior dental and inferior labial arteries.

The next branch is the *inferior labial*, given off after the facial has made its curve upon the face. This supplies the muscles and integuments of the lower lip.

At the angle of the mouth is the *inferior coronary*. This sometimes supplies the place of the inferior labial.

A little higher is the *superior coronary*. Both these course along the margins of the lips, close to the mucous membrane, sending many branches to the substance of the lips, and forming by anastomosis with their fellows of the opposite sides, a complete circle round the mouth.

The *lateralis nasi* is the next in order, supplying the side and dorsum of the nose; while the *angularis* is the terminating branch of the facial, anastomosing with the nasal branches of the ophthalmic. This artery in its ascent is connected by anastomosis with the lingual, the inferior dental as it escapes from the anterior mental foramen, the transverse facial and inferior orbitar arteries.

The *inferior* or *ascending pharyngeal artery* is one of the smallest branches of the external carotid, and varies in its origin. It mostly arises opposite to the lingual, sometimes higher up, and occasionally springs from one of the other branches. It ascends on the side of the pharynx, covered by the stylo-pharyngeus, to the base of the skull, where it divides into its two principal branches, the *pharyngeal* supplying the pharynx, tonsils, palate, and Eustachian tube, and the *posterior meningeal* passing through the foramen lacerum posterius, and distributed upon the dura mater at the base of the brain.

The *occipital artery* arises opposite the facial, proceeds backward behind the digastric, the sterno-mastoid, and trachelo-mastoid muscles along the groove within the mastoid process, and then ascends upon the occiput between the complexus and splenius muscles, anastomosing with its fellow, the posterior auricular, and the temporal arteries.

Its principal branches are muscular, supplying the muscles just mentioned; the *inferior meningeal*, which ascends through the foramen lacerum posterius, to the dura mater, and the *princeps cervicis*, which is a large branch and may be regarded as the continued trunk of the occipital. It descends to the deep muscles of the neck, and anastomoses with the profunda cervicis of the subclavian, thus preserving the circulation, when the common carotid is ligated.

Posterior auricular artery is a small branch, and arises a

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Posterior auricular artery is a small branch, and arises a

little above the occipital, not unfrequently in common with it; it ascends behind the parotid gland, between the mastoid process and the meatus auditorius, supplying the integuments of the posterior ear and scalp. Some of the branches are seen to pass through the pinna to the anterior surface of the ear. Its only branch having a name, is the *stylo-mastoid.* This enters the stylo-mastoid foramen, and distributes branches upon the aqueduct of Fallopius and the tympanum.

The *temporal artery* (Fig. 120) is one of the terminating branches of the external carotid. It ascends through the substance of the parotid gland, over the root of the zygoma, in front of the meatus auditorius, about an inch and a half above the zygomatic arch, where it terminates by dividing into an anterior and posterior branch. Its branches are the *anterior auricular* to the anterior part of the pinna. The *transverse facial* passes horizontally upon the face below the duct of Steno, crossing the masseter muscle to be distributed to the adjacent muscles and integuments, and anastomosing with the facial and infra-orbitar arteries. This artery often arises from the external carotid. The *middle temporal* passes through the temporal fascia and supplies the temporal muscle. The *anterior temporal,* one of the terminating branches, goes forward to the os-frontis, supplying the muscles and integuments in this region and anastomosing with its fellow of the opposite side, and with the supra orbital arteries. The *posterior temporal,* the other terminating branch, proceeds backward and upward, anastomosing with the posterior auricular and occipital arteries.

The *internal maxillary artery* (Fig. 121) is the remaining terminal branch of the external carotid. It is the great artery supplying the mouth and the whole of the dental apparatus.

Dissection.—Saw the zygomatic arch through at both ends, and turn it down with the masseter muscle; divide the tendon of the temporal muscle from its insertion into the coronoid process; divide the ramus about its centre and disarticulate. Remove the jaw with the external

pterygoid muscle, when this artery, with the deep branches of the inferior maxillary nerve, will be exposed.

This artery commences in the substance of the parotid gland, opposite the meatus auditorius externus; passes horizontally inward behind the neck of the lower jaw, between it and the internal lateral ligament, and between the inferior dental and gustatory nerves, to the space between the pterygoid muscles; at this point it passes either between these muscles, or winds over the pterygoideus externus, describing a tortuous course forward, inward, and somewhat upward to the tuberosity of the superior maxillary bone, upon which it makes a considerable curve, and then dips down into the pterygo-maxillary fossa, where it terminates. Its branches are as follow:

A *tympanic* branch, which passes through the glenoid fissure to the tympanum, and also supplies the temporo-maxillary articulation. The *greater meningeal*, or middle artery of the dura mater, coming off behind the neck of the lower jaw, ascends to the foramen spinale of the sphenoid bone, through which it passes into the cranium, and there divides into an anterior and a posterior branch, which diverge and occupy the grooves on the internal surface of the parietal and temporal bones, supplying the dura mater and the anterior cranial bones. The *lesser meningeal* passes through the foramen ovale to the dura mater, and is often a branch of the greater. The *inferior dental* or *maxillary*, as has already been described, arises opposite the greater meningeal behind the neck, and descends between the bone and internal lateral ligament to the posterior dental foramen, which it enters along with the inferior dental nerve; it then follows the course of the canal beneath the roots of the teeth, into each of which it sends successively a small branch, till, arriving opposite the bicuspid, it divides into two branches, one of which comes out at the anterior mental foramen to supply the chin, and anastomose with the facial; while the other is the continued trunk going forward as far as the symphysis, and supplying the canine and incisor teeth.

The *posterior deep temporal* arises next in order; it is concealed by the external pterygoid and temporal muscle, and is distributed to this latter muscle.

The *pterygoid arteries* come next; they vary in number and size, and, as their name implies, supply the pterygoid muscles.

The *masseteric* and the *buccal* go to the masseter and buccinator muscles, and also give branches to the lining membrane of the mouth. The buccal sometimes comes from the superior dental, or the next branch in order.

The *anterior deep temporal*, which comes off just before the internal maxillary, enters the pterygo-maxillary fossa, and ascends to be distributed upon the temporal muscle, anastomosing with the posterior and middle deep temporal.

The *superior dental* or *alveolar* comes off next, and has been stated, in noticing the vessels supplying the teeth, to wind round the tuberosity of the superior maxillary bone, sending branches through the posterior dental canals, to the molar teeth, and to the lining membrane of the antrum; it then proceeds forward along the alveoli, supplying them and the gums.

The *inferior orbital* arises at the upper part of the pterygo maxillary fossa, and after sending a few branches into the orbit, through the spheno-maxillary fissure, it enters the infra orbitar canal, in company with the infra orbitar nerve, and on arriving near the anterior orifice of this canal, it sends downward a branch to supply the incisor and canine teeth, and lining membrane of the antrum. It finally emerges at the infra orbitar foramen, anastomosing with the ophthalmic and facial arteries.

The *superior palatine* also comes off in the pterygo-maxillary fossa, and descends to the posterior palatine canal, distributing branches to the soft palate; it then curves forward, in a groove, upon the hard palate, internal to the alveoli, giving off ramifications to the lining membrane of the roof of the mouth, and proceeds to the foramen incisivum, to anastomose with the spheno-palatine or nasal artery.

The *superior pharyngeal*, or *pterygo-palatine*, is sometimes a branch of the latter, and supplies the upper part of the pharynx and Eustachian tube. The *spheno-palatine*, or *nasal*, is the terminating trunk of the internal maxillary, and passes along with the nerve of the same name, through the spheno-palatine foramen, into the nose, where it divides into two branches—one going to the septum, the other to the middle and lower turbinated bones, and their mucous membrane.

BRANCHES OF INTERNAL CAROTID ARTERY. (Fig. 119.)

Tympanic branch.
Anterior meningeal.
Ophthalmic—its branches,
- Lachrymal.
- Central artery of the retina.
- Supra-orbital.
- Short ciliary.
- Long ciliary.
- Muscular.
- Posterior ethmoidal.
- Anterior ethmoidal.
- Palpebral.
- Nasal.
- Frontal.

Anterior cerebral.
Middle cerebral.
Posterior communicating.
Choroidean.

BRANCHES OF VERTEBRAL ARTERY.

Posterior spinal.
Anterior spinal.
Inferior cerebellar.
Basilar—formed by junction of two vertebral. Its branches are,
- Superior cerebellar.
- Posterior cerebral.

All these vessels have been described under the respective heads of Blood-vessels of the Brain and Eye, which see. The veins, corresponding to the branches of the external carotid, have both a similar course and name, so that a repetition would be unnecessary here.

SECTION IV.

TABLE OF MUSCLES OF THE HEAD.

According to the arrangement of Mr. Harrison, these muscles are classed in accordance with the part upon which they chiefly act. Six classes are made, embracing thirty-six pair, and two single muscles.

FIRST CLASS—*one muscle*,

The muscle of the Scalp, or Occipito-Frontalis.

SECOND CLASS—*eleven muscles*,

Those of the *Ear*, which are arranged into three groups.

First Group—three muscles :

Superior auris, or Attollens aurem.
Anterior auris, or Attrahens aurem.
Posterior auris, or Retrahens aurem.

Second Group—five muscles :

Tragicus.
Antitragicus.
Helicis major.
Helicis minor.
Transversalis auris.

Third Group—three muscles :

Stapedius.
Tensor tympani.
Laxator tympani.

THIRD CLASS—*eleven muscles,*

Those of the *Eye* and *Appendages*, are arranged in two groups—one of which acts on the appendages, the other on the ball of the eye.

First Group—five muscles :

Occipito-Frontalis — its palpebral insertion.
Corrugator supercilii.
Levator palpebræ superioris.
Orbicularis palpebrarum.
Tensor tarsi.

Second Group—six muscles :

Rectus superior, or Levator oculi.
Rectus inferior, or Depressor oculi.
Rectus internus, or Adductor oculi.
Rectus externus, or Abductor oculi.
Obliquus superior.
Obliquus inferior.

FOURTH CLASS—*four muscles,*

Those of the *Nose*, arranged in two groups :

First Group—proper to the Nose :

Pyramidalis nasi.
Compressor nasi.

Second Group—common to the Nose and upper Lip :

Levator labii superioris alæque nasi.
Depressor labii superioris alæque nasi.

FIFTH CLASS—*ten muscles,*

Those of the *Mouth*, arranged in four groups :

First Group—one muscle :

Orbicularis oris.

Second Group—two muscles common to the upper Lip and Nose :

Levator labii superioris alæque nasi.
Depressor labii superioris alæque nasi.

Third Group—two muscles :

Levator labii inferioris.
Depressor labii inferioris.

Fourth Group—five muscles :

Levator anguli oris.
Depressor anguli oris.
Zygomaticus major.
Zygomaticus minor.
Buccinator.

SIXTH CLASS—*muscles of mastication,*

Which act on the lower jaw, and are four pair :

Masseter.
Temporal.
Pterygoideus externus.
Pterygoideus internus.

CHAPTER VI.

ANATOMICAL AND PHYSIOLOGICAL RELATIONS OF THE MOUTH WITH THE DIFFERENT PARTS OF THE HEAD.

The *mouth*, from the detailed description already given, it will be perceived, is a very complex apparatus, comprising organs of the greatest variety, in form, size, delicacy and adaptation, and embodying functions equally various and useful, as seen in the multitude of duties they perform, their surprising promptitude and harmony of action, and their universal *sympathy* and *relation* with all the various parts composing the head; and we may add the rest of the body likewise, as we shall have to show in the proper place. So close and so essential is this mutual relation of the mouth and head, that they cannot exist separately.

It is only necessary here to make a very general enumeration of these relations with the mouth, so as to impress especially upon the dental student their *magnitude* and *importance*.

The mouth, it will be recollected, consists of the anatomical elements of *bone*, *muscle*, *blood-vessel*, *nerve*, *gland*, *cellular*, *mucous* and *adipose structure;* which, variously combined, constitute the upper and lower jaw, the teeth, the gums, the tongue, the palate, the tonsils, the cheeks, &c., in a word, all the parts forming the walls of the cavity of the mouth, as well as the various organs contained within it. Now each one of these elements, and of the several organs they form, has a relation more or less direct and intimate with the other portions of the head.

The *upper jaw-bone* is connected to a number of the bones of the cranium and face, thereby forming one continuous whole, containing numerous cavities of various sizes and uses, as the cavity of the cranium for lodging the brain; the orbital and nasal cavities, the maxillary sinus, &c. The *lower jaw*, by its articulation with the temporal bones, presents a fulcrum and lever, which, in connection with the

various muscles attached to it and the head, is in its power, strength, beauty and mechanical contrivance, incomparably superior to any thing in human mechanics. The *teeth* have not only a direct connection with the jaws, but by means of their blood-vessels and nerves, they have nearly as direct and close a relation with the brain and its membranes, the eye, the ear, and the nose. The fifth pair of nerves come from the brain and send branches to the teeth, jaws, eyes, nose, ears, &c., endowing the whole with sensibility to pain, and so close is this sympathy manifested between the teeth and brain, that the simple act of teething frequently occasions the most frightful convulsions; while cases are not wanting to show that irritation of this same set of nerves, from decayed teeth, has been the cause of *tic-douloureux*, ulceration of the eye, photophobia, blindness, and the most excruciating pain of the ear. The internal maxillary artery is the principal vessel establishing the vascular relationship between the mouth and brain, and other parts of the head and face.

In congestion, apoplexy, and delirium, the condition of the circulation in the brain is reported by an almost similar state of the circulation in the mouth. The gums, tongue, palate, tonsils, &c., by the same kind of anatomical relationship of blood-vessels and nerves, display each their several sympathies with the other portions of the head.

We now pass to the second division, the *physiological relations* of the mouth with the different parts of the head.

The *functions* of the mouth have been stated to be those of *prehension*, *mastication*, *insalivation*, *suction*, *deglutition*, and *speech;* functions lying at the very foundations of life and connecting man with the outer world.

The first series of these functions comprises the commencing stages of *digestion*, which comprehend the preparatory but essential elements in that grand and fundamental process of nutrition, which not only builds up the head in all its different parts, and supplies its daily and unceasing waste, but further preserves, with an ever vigilant and untiring care, all its various relations with the mouth, and

extends its influence throughout the whole and every part of the body.

The last mentioned function of the mouth, *speech*, is more closely related with the brain, though it has the same organs for its performance, as those employed in the above functions of the first stages of digestion. For this function is impaired when the teeth are lost, the palate cleft, the tonsils swollen, or the lip cleft, and it is partially or entirely lost in congestion and apoplexy of the brain.

PART THIRD.

THE LANGUAGE OF ANATOMY.

II. THE TRUNK.

PART THIRD.

CHAPTER I.

THE TRUNK.

PASSIVE ORGANS OF THE TRUNK.

THE BONES.

Division.—1. Spine. 2. Thorax. 3. Pelvis.

SECTION I.

THE SPINE OR VERTEBRÆ.

The *spine*, so called from its posterior projecting processes resembling thorns, is *situated* on the posterior median line of the trunk, and is composed of a column of bones, called *vertebræ*, placed one above the other in a regular series from top to bottom, and designated the *vertebral column*.

The vertebræ are divided into *true* and *false*. The twenty-four movable bones are the true; the *sàcrum* and *coccyx*, which assist in forming the pelvis, the false. The true and false vertebræ form an upright rod or column, having four curvatures, one in the neck, concave behind and convex in front; a second in the back, concave in front and convex behind; a third in the loins, concave behind and convex in front, and a fourth in the pelvis, concave in front and convex behind. This arrangement is found to add greatly to the strength of the spine, and results from the difference in the thickness of the bodies of the several vertebræ, as well as of the intervening fibro cartilage.

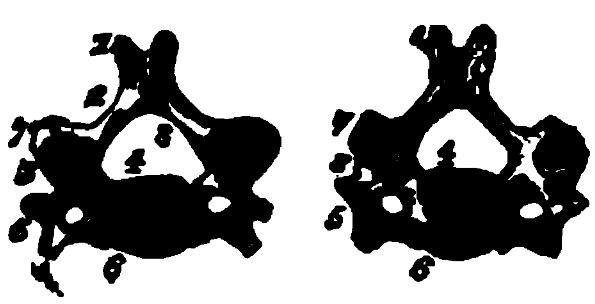
The true vertebræ are divided into *cervical*, *dorsal*, and *lumbar*, as they are found in the *neck*, the *back*, or the *loins*. The *length* of the true spine is estimated as a general rule at twenty-four inches; six inches being

spinous, two for the transverse, and one for the upper and lower surfaces of the body.

The three primary centres present their ossific points about the seventh or eighth week, those of the lateral portions being observed a little in advance of the body, and at birth the three pieces are found separate. In the first year union begins with the lateral portions and at their posterior part, where they come together to form the spinous process, and during the third and fifth year with the body. The osseous nuclei for the extremities of the spinous and transverse processes, are seen about the fifteenth or sixteenth year, and their union is not completed till the twenty-fifth or thirtieth year.

CERVICAL VERTEBRÆ—COMMON CHARACTERISTICS.

A FIG. 124. B



The cervical vertebræ *occupy* the superior portion of the column, are seven in number, and are the smallest in *size*. The superior surface of each is concave from side to side, and bounded by a vertical ridge; the lower surface is concave from before backward, and has a ridge at the anterior edge. The lateral processes are narrow and long, and bound a large and triangular canal.

The *spinous process* is *bifid*, short and horizontal. The *transverse* is short and perforated at its base by a foramen for the passage of the vertebral vessels. Its upper surface is grooved for the cervical nerves.

FIG. 124, A represents the *upper surface* of a Cervical Vertebra. 1 Spinous process bifurcated. 2 Lateral lamina. 3 Superior articular process. 4 Posterior surface of body. 5 Transverse process bifurcated. 6 Anterior surface of body. 7 Extremity of superior articular process. 8 Vertebral foramen for spinal marrow.

FIG. 124, B represents the lower surface of the same vertebra. 1 Spinous process bifurcated. 3 Posterior root and notch of transverse process. 5 Bifurcation of transverse process, and the process showing a foramen in it for giving passage to the vertebral artery. 6 Body of vertebra. 7 Inferior articular process. 4 Foramen for the spinal marrow.

The oblique articular processes are oval, the two superior being directed upward and backward, and the two inferior downward and forward; the surfaces of the superior are rather convex, those of the inferior concave.

CERVICAL VERTEBRÆ—INDIVIDUAL CHARACTERISTICS.

The *atlas*, or first cervical vertebra, so called from supporting the head, differs from the rest in having no body nor spinous process, and consisting simply of a bony ring. A tubercle marks this ring on its anterior portion; behind, on the same part, the surface is concave, smooth, and oval, for articulating with the tooth-like process of the axis or second vertebra. The upper and lower edges of this ring are for the attachment of ligaments. The posterior arch is long, slender, and presents a tubercle instead of a spine, upon the upper surface of which, near the oblique processes, is a groove for the vertebral artery, in making its curve, to enter the brain. It also receives the sub-occipital or first cervical nerve. The spinal foramen is very large, and divided by the transverse ligament into two; the anterior and smaller receives the odontoid process, the posterior and larger contains the spinal cord. The intervertebral notches are behind instead of being in front of the oblique processes, as in all the other vertebræ. The superior oblique processes are horizontal, concave, and their smooth surfaces look from before, backward and outward; they articulate with the condyles of the occipital bone, and are admirably adapted to the nodding motion of the head. The

A FIG. 125. B

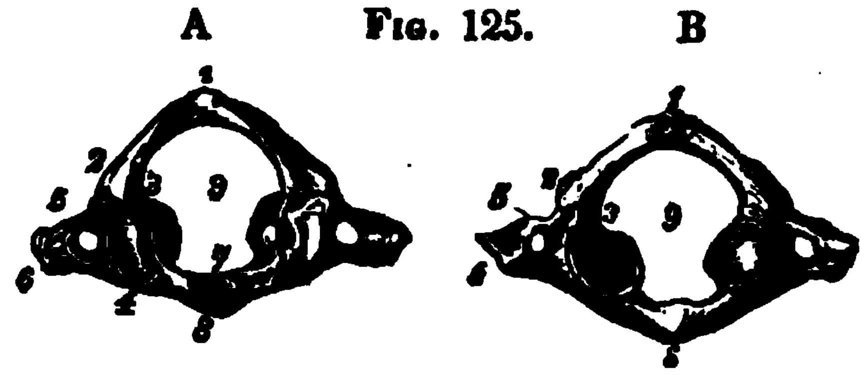


FIG. 125, A represents the upper surface of the Atlas. 1 Tubercle in place of spinous process. 2 Posterior part of ring of atlas. 3 Where the transverse ligament is attached. 4 Superior articular process. 5 Groove leading to vertebral foramen. 6 Transverse process. 7 Articular surface for odontoid process. 8 Anterior margin of ring of atlas. 9 Foramen for spinal marrow.

FIG. 125, B represents the lower surface of Atlas. 1 Tubercle in place of spinous process. 2 3 4 5 6 7 8 9 Correspond to similar points, as in Fig. 125, A.

inferior are circular, nearly flat, and suited to the rotatory motion. The transverse processes are noted for their great length—projecting much beyond those below, and have the foramen at their base for the passage of the vertebral artery.

The *axis*, or second cervical vertebra, is also called the *dentata* from its tooth-like or odontoid process, which is the peculiar characteristic of this vertebra. This process arises from the central part of the superior surface of the body, and ascends vertically. It presents somewhat the form of a tooth—hence its name. Its anterior surface is smooth, and articulates with the anterior arch of the atlas. Its posterior is also smooth, and has the transverse ligament in connection with it. Its apex is pointed for the attachment of the vertical ligament, and upon each side, from a rough surface, originate the moderator or check ligaments. This process is the pivot round which turns the atlas. The spinous process is long, large, and forked. The spinal foramen is heart-shaped. The superior oblique processes are seen, on each side of the odontoid, on a plane anterior to those below, and are smooth, circular, and nearly horizontal. The inferior look forward and downward, and are flat. The transverse processes are short and not bifid—the body of this vertebra is large. The cervical vertebræ increase gradually in size to the seventh, (Fig. 127.)

The seventh cervical is called *vertebra prominens*, from its

FIG. 126.

FIG. 127.

FIG. 126 represents the *Dentata* or second bone of the Vertebræ. *a* Body. *b* Odontoid process. *c* Articular face for atlas. *d* Foramen for vertebral artery. *e* Spinous process. *f* Inferior oblique process. *g* Superior oblique process.

FIG. 127 represents the seventh cervical vertebra, seen from below. 1 Spinous process. 2 Vertebral foramen. 3 Articular process. 4 Lateral lamina. 5 Foramen for vertebral artery and vein. 6 Germ of the accessory rib. 7 Supernumerary rib at its styloid. 8 Body.

long spinous process, which projects beyond all the rest and is readily felt beneath the skin, ends in a tubercle and is not bifurcated, and gives attachment to the ligamentum nuchae. Its transverse processes have no foramina, or if there be any, they are small and transmit only a vein.

PECULIARITIES OF DEVELOPMENT IN THE CERVICAL VERTEBRÆ.

The *atlas*, instead of the usual three primary ossific centres, is seen to have four and sometimes five; one for each lateral portion, one, occasionally two, for the anterior arch, and one for the centre of the posterior arch. The lateral centres unite with the posterior centre during the second and third years, and with the anterior about the fifth or sixth year. The *axis* is found with five centres of ossification, two for the odontoid process, one, sometimes two, for the body, and one for each lateral part. The body and odontoid process begin ossifying about the sixth month, and are found united about the third or fourth year. The lateral portions unite soon after birth, and join the body about the fourth or fifth year.

The *seventh cervical vertebra* is found to have the anterior portion of its transverse process frequently presenting a separate osseous centre about the second or sixth month, which unites with the body about the fifth or sixth year. Separate ossific centres have also been noticed in the transverse processes of the second, fifth and sixth cervical vertebræ, and also the first lumbar.

DORSAL VERTEBRÆ—COMMON CHARACTERISTICS. (Fig. 128.)

The dorsal vertebræ occupy an intermediate position between the cervical and lumbar, and are also intermediate in *size;* they become less and less from the first to the third or fourth, and then increase to the last. The body is thicker behind than before, and more cylindroid than those of the neck; the upper and lower surfaces at the posterior edge, near the origin of the lateral processes, present two small articular facets for receiving one half of the head of each rib—the adjoining vertebra having a corresponding de-

A FIG. 128. B

pression for the other half. The lateral processes are broad. The spinous are triangular, long, ending in a tubercle and bending downward so as to overlap each other. The oblique processes are vertical—the superior facing directly backward—the inferior as directly forward. The spinal foramen is round and large. The transverse processes are directed backward, are large and long, and have their front surfaces at the extremities smooth, for articulation with the tubercle of the ribs. This is true of all except the last two; they have no articulating surfaces. The intervertebral foramina for the nerves are large.

DORSAL VERTEBRÆ—INDIVIDUAL CHARACTERISTICS.

The first and the last two dorsal present individual peculiarities. The first has a full articulating surface on each side, and receives the whole head of the first rib, and also has at its inferior edge a half articular surface for the half head of the second rib. The flatness of the body and its projecting spinous process resembles it to the cervical. The three lower dorsal approximate in their appearance to those of the loins. They have full depressions in the middle and sides, for their corresponding ribs, and the last two have no articular surfaces on their transverse processes. The tenth dorsal has occasionally on its transverse process the articular face.

LUMBAR VERTEBRÆ—COMMON CHARACTERISTICS. (Fig. 129.)

The lumbar vertebræ are five in number; occupy the lower part of the column, and are much the largest in *size*

FIG. 128, A represents a dorsal vertebra seen from above. 1 Spinous process. 2 Transverse process. 3 Articular facet for the articulation of the rib. 4 5 Articular process and notch. 6 7 Body. 8 Foramen for spinal marrow.

FIG. 128, B represents a side view of the same vertebra. 1 Body. 2 Articular face for head of the rib. 3 Superior articular process. 4 5 Transverse process and articular face. 6 Spinous process. 7 Inferior articular process. 8 Notch, intervertebral.

of all the true vertebræ. The bodies are deeper before than behind, and broad transversely. The superior and inferior surfaces are flat and oval, having projecting and hard edges. The intervertebral notches are very large, especially the lower—the spinal foramen is triangular or oval, and larger than in the dorsal. The *spinous process* is broad, thick, and short, ending in a rough border. The oblique processes are vertical—the superior being concave and looking inward—the inferior convex and looking outward and forward. The transverse are long, slender, and stand at right angles. The fifth or last lumbar vertebra is somewhat peculiar in having its body of greater size, deeper generally in front than behind, so as to give something of the wedge shape; in its transverse processes being thick, short, and round, and in the spinal foramen being larger.

FIG. 129.

The *false* or *pelvic vertebræ* consist of the *sacrum* and *coccyx*.

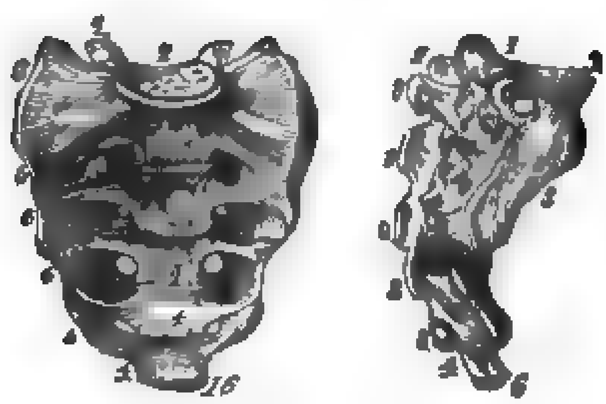
The *sacrum* is *situated* at the lower part of the true vertebræ, occupying the posterior and superior portion of the pelvis. Its *form* is triangular, and its position is like that of a wedge, its base being above, and apex below—having the innominata laterally—the lumbar vertebra upon its superior, and the coccyx on its inferior portion. This bone, in the adult consisting of one piece, in the child forms five pieces. Its *surfaces* are the *anterior*, *posterior*, and two *lateral*.

The *anterior surface* is concave from above downward, and marked by four transverse lines, showing the original divisions of the bone into five pieces. At the outer extremity of these lines four foramina are observed, called the *anterior sacral foramina*, for transmitting the anterior sacral nerves. The two superior of these foramina are quite large—the rest diminish in size as they descend; they are

FIG. 129 represents the upper surface of a lumbar vertebra. 1 Spinous process. 2 Lateral lamina. 3 Superior articular process. 4 Transverse process. 6 7 Body. 8 Vertebral foramen.

all smooth, funnel-shaped, and have their orifices looking outward. The anterior projecting edge of the upper bone of the sacrum is called its *promontory*.

A FIG. 130. B



The *posterior surface* is rough and convex; on its middle line four prominences are observed corresponding to spinous processes, which are not unfrequently seen united into a single ridge or crest. The fourth and fifth spines are generally deficient, leaving a triangular space which is simply closed by ligaments, and in place of the spine, presenting, on either side, two tubercles styled *cornua*, which unite with similar cornua from the coccyx, forming foramina for the passage of the last sacral nerve.

On either side of the spinous processes four foramina are seen, smaller than those in front, transmitting the posterior sacral nerves. External to these foramina, a row of five tubercles is noticed, though indistinct, corresponding to the transverse processes of the true vertebræ; and internal to these foramina, between them and the spinous processes, another row of indistinct tubercles is seen, regarded as analogous to the oblique processes.

The lateral or iliac surfaces are rough, irregular, and triangular, having their superior portions broad and covered with cartilage to articulate with the ilium. Their inferior surfaces are thin, and give attachment to the greater and lesser sacro-ischiatic ligaments.

FIG. 130, A represents a front view of the Sacrum. 1 Superior articular process. 2 Superior surface of first sacral vertebra. 3 Lateral side of sacrum. 4 Anterior surface of the bodies of the sacral vertebra. 5 Grooves leading to the anterior sacral foramina. 16 Apex of last sacral vertebra.

FIG. 130, B represents a side view of the Sacrum. 1 Superior articular process. 2 Sacro vertebral angle. 3 Hollow of the sacrum. 4 Termination of sacral canal. 5 Articular surface for coccyx. 8 8 8 Spinous processes, or crest.

On the *upper surface*, in the centre, is an oval articulating surface for uniting with the last lumbar vertebra. On each side of this is seen a broad triangular expansion, upon which rests the psoas magnus muscle, and lumbo-sacral nerve. The anterior edge of this expansion is continuous with the linea ileo-pectinea. Between this expansion and the oblique process is a groove for the fifth lumbar nerve. The lower extremity of the sacrum is truncated and presents a small oval surface for articulation with the coccyx.

The structure of the sacrum is mostly spongy and cancellated, thick, yet very light, and covered by a thin compact layer. Its *development* occurs usually from twenty-one points of ossification; five for each of the three superior divisions, one for the body, one for each lamina, and one for each lateral portion. The two lower divisions have each three points, one for the body and one for each lateral portion. As many, however, as thirty-four and thirty-five points of ossification have been observed. Ossification is observed to commence in the bodies of the three upper sacral vertebræ, about the eighth or ninth week, a little later than that of the true vertebræ, in the two lower about the fifth month, and in the lateral portions from the sixth to the ninth month. The union of these latter with the body is found to take place from below upward, and in the following order: the fifth piece about the second year, and the first not before the fifth or sixth year. The epiphyses are developed about the fifteenth or eighteenth year, and the sacrum is completely fused into one piece by the thirtieth year.

It is *articulated* above with the last lumbar vertebræ, below with the coccyx, and laterally with the two ossa innominata.

Coccyx—(κόκκυξ, *cuckoo*, from likeness to a cuckoo's beak,) is situated at the lower extremity of the sacrum, and corresponds to the tail of the inferior animals, (Fig. 131.) It consists of four caudal vertebræ, sometimes only three, which in the old are often consolidated into two or a single piece. Its *shape* is triangular, the base above, broad and

articulating with the sacrum. Upon each side of the base at its posterior part, a small *process* or *cornu* arises to unite with a similar one upon the sacrum, forming a foramen for the passage of the fifth sacral nerve. The three lower pieces diminish in size to the last, and in old age, as already stated, become firmly fused together and also with the sacrum, presenting one solid piece.

Fig. 131.

The anterior or pelvic surface of the coccyx is smooth, concave, and marked by three transverse lines, denoting its original separation into four pieces. This surface supports the rectum. The posterior surface is rough, presenting ridges and tubercles to which ligaments and muscles are attached.

The *coccyx* is light and spongy. Its *development* is from four points, one to each piece. Ossification in the coccyx is noticed soon after birth in the first piece, from five to ten years in the second; from ten to fifteen in the third; and from fifteen to twenty in the fourth piece; the several pieces unite in pairs—the first in order are the two first pieces, then the third and fourth, and lastly the second and third; and between forty and sixty years the coccyx becomes united with the sacrum. Its union with the sacrum by fusion, is much earlier in the male than in the female.

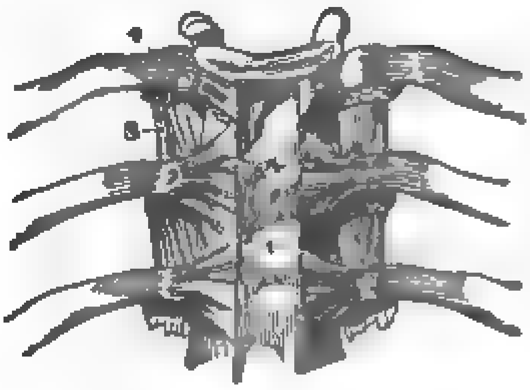
LIGAMENTS OF THE SPINE—COMMON ARTICULATIONS OF THE VERTEBRAL COLUMN.

1. The *anterior vertebral ligament*, (Fig. 132,) as its name implies, is *situated* on the front surface of the spinal column, *extending* from the axis to the sacrum, and consists of fibres which are broad and strong, increasing in breadth as they descend, and adhering more strongly to the intervertebral matter, than to the bodies themselves. The fasciculi of this ligament vary in length and thickness. The superficial fibres are long and run to several vertebræ. The

Fig. 131 represents a front view of the Coccyx. 1 Upper articular surface for last lumbar vertebra. 2 Cornu of coccyx. 3 Transverse process. 4 4 4 Margin of the four bones.

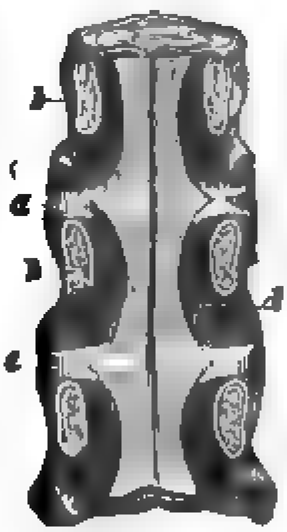
deep ones are short and extend simply to adjoining vertebræ. It is thin in the neck, thicker in the back, and again becomes thin in the loins. The use of this ligament is to bind together the several vertebræ, and prevent over-extension of the spine.

Fig. 132.



2. The *posterior vertebral ligament* (Fig. 133) is situated upon the back part of the bodies of the spinal column, within the canal, and extends from the axis to the sacrum, the fibres being traced still higher to the cuneiform process of the os-occipitis, and lower to the coccyx. This ligament has its fibres arranged in a similar manner to the anterior, consisting of short and long. It is broad over the intervertebral substance, to which it is also more adherent. It is loose upon the bodies, being separated by the veins which escape from the large foramina seen on this surface. This ligament antagonizes the former by opposing excessive flexion of the spine, while, at the same time, it assists in binding together and strengthening the several vertebræ.

Fig. 133.



3. *Intervertebral ligaments* are situated between the bodies of each vertebra, except the first and second. Their *structure* is of a mixed character, partaking both of ligament and cartilage, hence called also *fibro-cartilages*. They are so strongly united to the upper and lower surfaces of the vertebræ, that it requires even maceration for a complete separation.

Fig. 132 represents the Anterior Vertebral Ligament. 1 Anterior vertebral ligament. 2 Anterior costo-vertebral ligament. 3 Internal transverse ligament. 4 Inter-articular ligament.

Fig. 133 represents the Posterior Vertebral Ligament. *a a* Intervertebral substance. *b b* Surfaces of bony bridges where cut. *c* Posterior vertebral ligament. *d* Opening for a vertebral vein.

Their thickness varies in different parts. In the neck and loins the thickness is greater before than behind—while in the back it is less. The curves of the spine are due, in great measure, to this substance. A transverse section of this ligament shows its fibres to run in a concentric form, being very close and compact near the surface, and as they approach the centre, spaces or interstices are left, containing a soft, pulpy, semi-fluid substance, while in the centre, the spaces become still wider and more cellular, and present still more of the pulpy matter. This central pulpy and conical body is a movable, elastic fulcrum, upon which the different vertebræ turn. It is more abundant, softer, whiter, and more transparent, in proportion, in infancy, than in any after period. In old age it diminishes both in quantity and elasticity, which accounts, in some measure, for the stiffness of the spine in old people.

The use of the intervertebral ligaments is manifold. They, in common with those just described, tie the several vertebræ together; they help to form the spinal canal, give sockets to the heads of the ribs, allow the flexibility of which the spine is capable; and, by their elasticity, preserve the spine of its uniform height: they also lessen the effects of shocks from concussion.

4. *Ligamenta subflava*, or *yellow ligaments*, (Fig. 134.) These ligaments close the spinal canal behind, and are *situated* between the posterior arches of the different vertebræ. They are found between all the vertebræ from the axis to the sacrum. They are in pairs, on each side of the median line, and are twenty-three in number. They extend from the inferior margin of the lamina above, to the superior margin of the corresponding one below. Their *structure* consists of yellow elastic tissue,

FIG. 134.

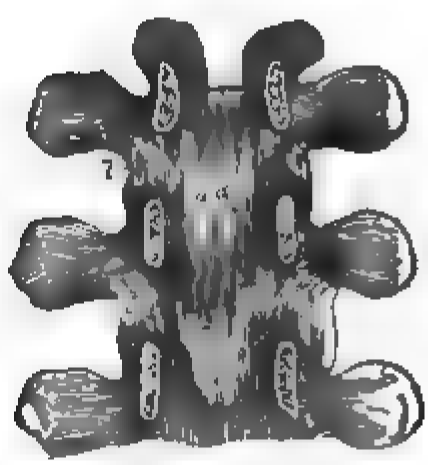


Fig. 134 represents the Yellow Ligaments (ligamenta flava.) *a a* One pair of the yellow ligaments. *b* Capsular ligament of the one side.

dense, very strong, and having the fibres vertical. They oppose flexion, and by their elasticity restore the spine to its erect condition.

5. The *Supra-spinous ligament* is found at the extremity of the spinous processes, from the last cervical vertebra to the sacrum. In the neck it is continued on to the occipital bone, under the title of *ligamentum nuchæ.* It separates the muscles on either side of the median line, and is the rudimentary structure of this very powerful ligament in the lower animals.

6. The *Inter-spinous ligaments* are situated between the spinous process of the dorsal and lumbar regions, above and below, and not between those of the neck. They are thin in the back, and thicker and stronger in the loins, and have the multifidus spinæ muscles attached to them.

7. The *Inter-transverse ligaments* are situated between the transverse processes of the lower dorsal and lumbar vertebræ, not being distinct either in the cervical or upper dorsal. They consist of thin fibrous membranes.

8. *Articulation of the oblique processes.*—These processes have an irregular capsule, consisting of ligamentous fibres not fully developed, extending from one bone to the other. Their articular surfaces are covered with cartilage, and connected by synovial membranes.

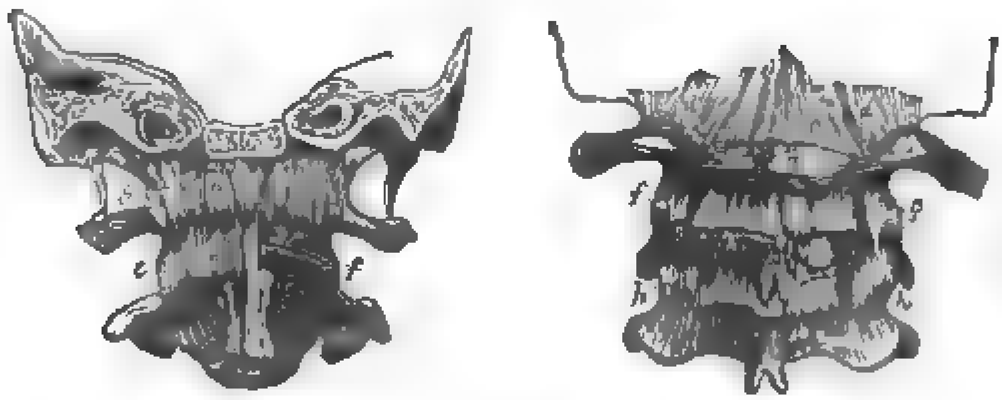
PECULIAR ARTICULATIONS OF THE VERTEBRAL COLUMN.

1. *Articulation of the atlas with the occiput.*—The condyles of the occipital bone, and the oblique processes of the atlas, are the bony portions especially concerned in the joint. There is the usual cartilage and synovial membrane at this joint; and also a ligamentous capsule, or *capsular ligament* on each side, which is attached to the circumference of the condyles and the margin of the glenoid cavity of the atlas. This capsule consists of thin and loose fibres which are, however, strong at the anterior and external parts.

Anterior ligaments, (*anterior occipito-atloid.*)—These are two in number, one a strong, round cord, *situated* on the median line, and extending from the basilar process to

the anterior tubercle of the atlas; the second, deeper than this, is broad and membranous, and extends from the ante-

A Fig. 135. B



rior margin of the foramen magnum, to the anterior arch of the atlas. These ligaments are covered in front by the anterior recti muscles, and behind are in relation with the dura mater.

The *posterior occipito-atlantal ligament* is attached above to the occipital foramen, and below to the posterior arch of the atlas. It is composed of a broad, thin and weak membrane, closely adheres to the dura mater, gives passage to the vertebral arteries and sub-occipital nerves, and is covered by the posterior recti and oblique muscles.

The *lateral ligaments*, one on each side, extend from the transverse process of the atlas, to the transverse process of the occiput, they consist of strong fasciculi of fibres, which expand and are continuous with the sheath surrounding the carotid vessels and nerves at the base of the brain.

2. *Articulation of the axis, or dentata, with the occiput.*—The ligaments connecting the axis or second vertebra with the

Fig. 135, A represents an anterior view of the Ligaments which connect the first and second vertebræ with the occiput. *a* Anterior occipito-atloid ligament. *b* Anterior annular ligament. *c* Where anterior vertebral ligament begins. *d e* Capsular ligament of oblique processes of atlas and dentata. *f* Joint between first and second cervical vertebræ. *g* External fibres of anterior annular ligament.

Fig. 135, B represents a posterior view of the ligaments which connect the first and second vertebræ with the occiput. *a* Atlas. *b* Dentata. *c* Posterior occipito-atloid ligament. *d d* Capsular ligament of oblique processes of the atlas and occipital condyles. *e* Ligament between the first and second vertebræ. *f f* Lateral fasciculi of this latter ligament. *g* First pair of the yellow ligaments. *h* Capsular ligament between the oblique processes of the second and third vertebræ.

occiput, are three, the *middle straight* and two *moderator* ligaments. The *middle straight ligament*, called *occipito-axoid* or *apparatus ligamentosus colli*, consists of a broad, thick band of fibres which extend from the cuneiform process, forming the foramen magnum, to the summit of the odontoid process, and pass on behind this process to be attached to the superior central portion of the transverse ligament of the atlas—and still lower down into the body of the second vertebra and into the bodies of the third and fourth, where they are continuous with the posterior common ligament.

FIG. 136.

The *moderator* or *oblique ligaments*, (Fig. 136,) called also the lateral alar or *check* ligaments, extend from each side of the odontoid process obliquely, upward and outward, to be attached above to the inner edge of each condyle.

These ligaments are short, thick, and strong, and limit the extent of rotation. They have in front the anterior occipito-atlantal ligaments and some cellular tissue, and behind the middle straight ligament.

3. *Articulation of the atlas with the axis or dentata.*—The ligaments of this articulation are five, (Fig. 136.) The *transverse*, *anterior* and *posterior atlanto-axoid*, and two *capsular*.

The *transverse* is *situated* behind the odontoid process, crossing the area of the atlas from the inner edge of the oblique process on the one side, to the same point on the opposite. It is a strong, thick, ligamentous band, concave, and smooth anteriorly, having a synovial membrane, and connected at this point with the odontoid process, forming a joint. At its centre, behind the process, some of its fibres ascend to join the middle straight ligament, and others

FIG. 136 represents the ligaments which unite the atlas and dentata with the occiput. 1 Posterior vertebral ligament, its upper portion. 2 Transverse ligament. 3 4 Appendices of transverse ligament. 5 Moderator or check ligament. 6 7 Capsular ligaments.

descend to be attached to the body of the axis, presenting, as seen in the figure above, a crucial appearance. The use of this ligament is to retain the odontoid process and the atlas in secure connection with each other.

The *anterior atlanto-axoid ligament* extends from the anterior tubercle and arch of the atlas to the base of the odontoid process, and is continuous with the anterior vertebral ligament. It is strong and thick.

The *posterior atlanto-axoid* is *situated* between the posterior arch of the atlas, and the lamina of the axis; it corresponds to the *ligamenta sub-flava*, is a thin, broad, and weak membrane, but not elastic.

The *capsular ligaments* are two in number, one on each side, and belong to the oblique processes of the atlas and axis. They surround the margins of these processes, and are loose enough to allow freedom of motion. They are, like all the oblique articulations, lined with synovial membrane, which occasionally communicates with the synovial membrane of the transverse ligaments and odontoid process.

The ligaments of the false vertebræ—the sacrum and coccyx, will be noticed along with those of the pelvis.

SECTION II.

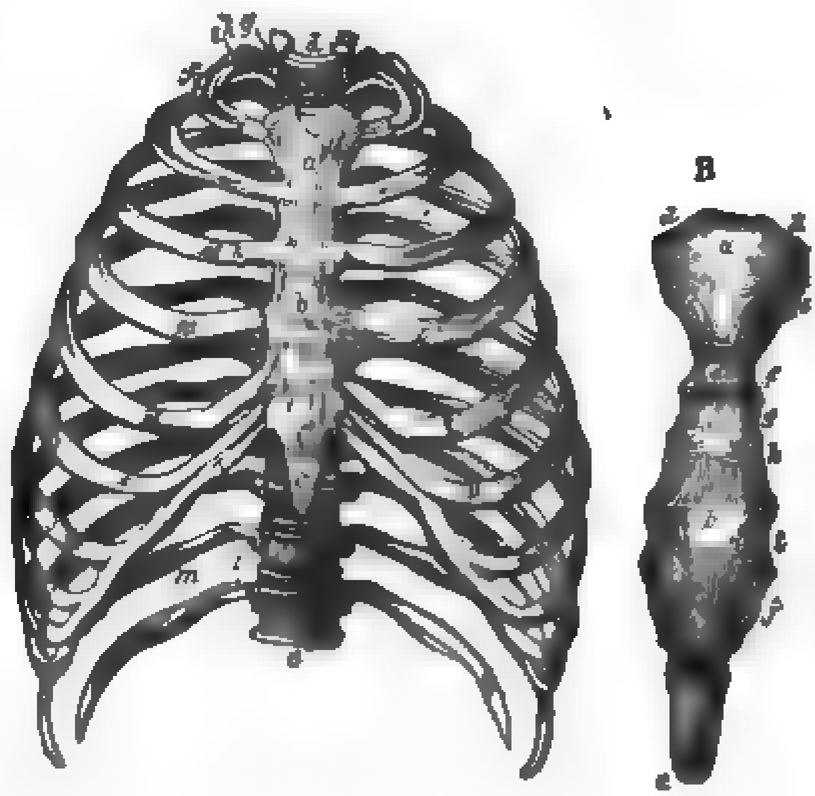
THE THORAX OR CHEST.

The *chest* forms the upper part of the trunk, and is composed of the *sternum* and *costal cartilages* in front—the *ribs* laterally, and the dorsal vertebræ, which have already been considered, behind. Its *form* is conoidal, flattened in front, rather concave behind, and convex upon the sides. Its summit or superior portion is smaller than the inferior or base, and presents a very oblique opening; cordiform in its shape, and much lower in front than behind. The base is a large foramen, bounded by the lateral and posterior margins of the lower ribs and their cartilages, marking the situation of the diaphragm.

The *sternum* (στερνον, the breast) is situated on the me-

dian line at the front part of the thorax. Its *direction* is obliquely downward and forward, its superior end being consequently nearer the spine than the inferior. Its upper portion is on a level with the third dorsal, and its lower with the eleventh dorsal vertebra. Its average length is six inches.

A Fig. 137.



The *sternum*, in the adult, consists of three pieces—a *superior*, *middle*, and *inferior*, which, in old age, are often fused into one. The *superior bone* is quadrilateral in shape, thick and broad above, narrow below, and concave transversely at its upper edge. The interclavicular ligament occupies this concavity, at either end of which, corresponding to the angles, are the articular cavities for the sternal ends of the clavicle. Just below this articulation is a depression on each side for the cartilage of the first rib, and still lower down, at the point of junction with the second piece, there is, on each side, a half fossa, which, with a similar one upon the second bone, receives the cartilage of the second rib. The *middle bone* is much longer than

Fig. 137, A represents a front view of the Chest. *a* First bone of the sternum. *b* Second bone of sternum. *c* Third bone of sternum, called ensiform cartilage. *d* First dorsal vertebra. *e* Twelfth dorsal vertebræ. *f* First rib. *g* Head of first rib. *h* Neck. *i* Tubercle. *j* Seventh or last true rib. *k k* Costal cartilages. *l* Floating ribs. *m* Groove for the intercostal artery.

Fig. 137, B represents the Sternum. *a* First piece. *b* Second piece. *c* Third piece, or ensiform cartilage. *d* Articular face for clavicle. *e* Articular surface for first rib. *f* Articular surface for second rib. *g h i j* Articular surfaces for the last five true ribs.

the upper; it is wide in the centre, and narrow at either end; its sides furnish cavities, complete for the third, fourth, fifth, and sixth ribs, and half cavities for the second and seventh ribs. These cavities approach nearer each other as they descend, so that the sixth and seventh are in contact.

The *inferior*, or third bone, called *ensiform*, or *xiphoid cartilage*, being usually in the cartilaginous state in the adult, is the smallest of the three pieces. It is thin, and varies much as to *form* and *size*, being sometimes pointed, sometimes bifid, sometimes thick—looking forward, and then backward, and occasionally perforated with a central foramen. Its base is united to the lower extremity of the middle bone; its sides have the transverse muscles of the abdomen attached to them, and its point is connected with the linea alba.

The sternum, as a whole, has its *anterior surface* flat, or a little convex—is covered by the aponeurosis of the pectoral muscles—has the tendons of the *sterno mastoid* muscles attached to its superior portion, and is crossed by transverse lines, marking its original divisions into as many as six pieces.

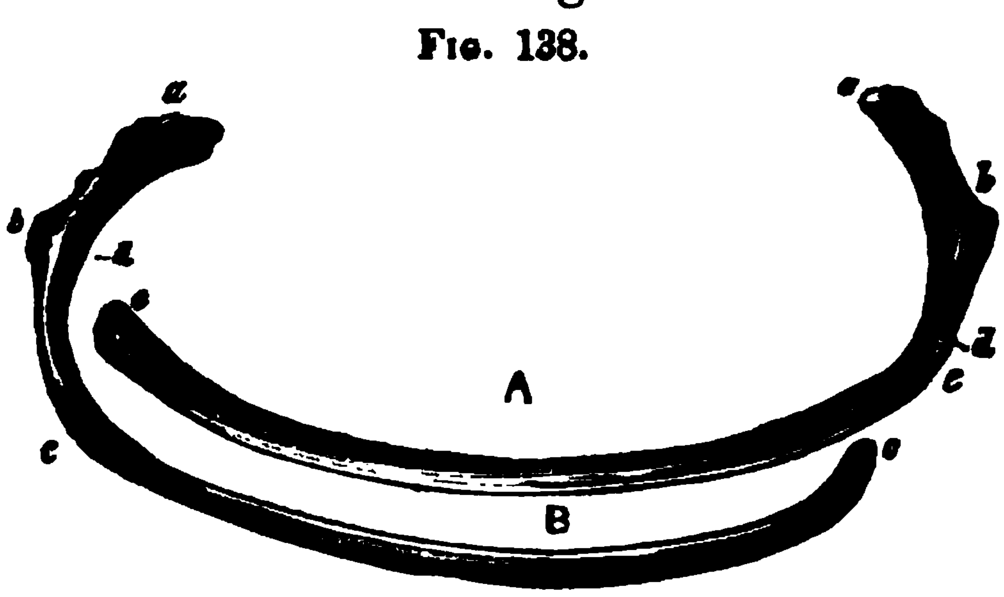
Its *posterior surface* is smooth, somewhat concave, and covered by a shining periosteum. It also presents transverse lines, though not so distinct as those in front. The *structure* of the sternum is spongy, covered by a thin compact layer. Its *development* is from a number of points varying from six to fourteen, which do not unite till late in life. The osseous centres for the first bone of the sternum are one or two in number, and make their appearance during the fifth and sixth months—those of the second and third soon after—and the fourth at the close of fœtal life or shortly after birth. Ossification of the ensiform cartilage varies from the second to the eighteenth year. The several pieces of the sternum commence uniting from below upward. The fourth and third are seen to join about puberty, the third and second between twenty and twenty-five, and the second and first between twenty-five and thirty years.

The ensiform cartilage does not join the sternum till late in life, about forty or fifty years. It *articulates* with sixteen bones, the two clavicles and seven true ribs on each side.

THE RIBS, (COSTÆ.)

The ribs are twenty-four in number, twelve on each side, and are divided into the *true* and *false*. The true are seven in number, extend from the vertebræ to the sternum, and are called *vertebro-sternal*. The false extend from the vertebræ to the ribs, and are called the *vertebro-costal* or *asternal*. The two last having their extremities free, are called *floating ribs*, and are the shortest. The ribs present an arched form, and run obliquely downward and forward from the vertebræ towards the sternum. They increase successively in length from the first to the eighth, and then diminish to the last. The *breadth* diminishes gradually from the first to the twelfth.

FIG. 138.



Common characters of the Ribs.—Each rib consists of two extremities, a *vertebral* and *sternal*, two surfaces, *external* and *internal*, and two margins, *superior* and *inferior*. The vertebral extremity or posterior end has a *head*, *neck*, and *tubercle*. The head is divided by a middle ridge into two articular faces, which are received into corresponding pits on two contiguous vertebræ, the edge between them sinking into the intervertebral substance. To the ridge the *inter-articular ligament* is attached. The *neck* is the contracted, round, and thick portion upon which the head rests. It is situated before the transverse process, to which it is attached

FIG. 138, A represents the upper surface, B the lower surface of a rib. *a* Head of rib. *b* Tubercle. *c* Anterior end for costal cartilage. *d* Groove for artery and nerve. *e* Angle of rib.

by the middle *costo-transverse ligament.* Its upper border has a ridge for the attachment of the *anterior* or *internal costo-transverse ligament.* The *tubercle* is external to the neck, and seen on the posterior under surface of the rib, about an inch from the head. It consists of two portions, an *internal* and *external.* The former is smooth, and articulates with the transverse process, the latter gives attachment to the *external costo-transverse* ligament. On the outside of the tubercle the rib makes a turn which is called its *angle.* To this the tendon of the *sacro lumbalis muscle* is connected. This angle increases in distance from the tubercle, from the first rib downward to the last, where it is not so distinct. The anterior or sternal extremity is hollow for the reception of the cartilage. Beyond or external to the angle, is the *body* or *shaft* of the rib. Its *external surface* is convex and smooth, and gives attachment to various muscles. Its *internal surface* is concave and lined by the pleura. Its *superior margin* is smooth and round, and gives attachment to the intercostal muscles. The *inferior* is thin and sharp, and has its inner side grooved, to lodge the intercostal vessels and nerves, and for the attachment of the intercostal muscles.

Characters peculiar to some of the ribs.—The *first* is the shortest—it is flat, strong and broad—has its surfaces presenting upward and downward, instead of forward and backward, has no angle and is not twisted. Its head has but one articular surface, and is not divided. There is no groove on the inferior or rather posterior edge. On the central part of the upper surface there is a broad and shallow fossa for the subclavian artery. In front of this is a slight eminence for the scalenus anticus muscle.

FIG. 139.

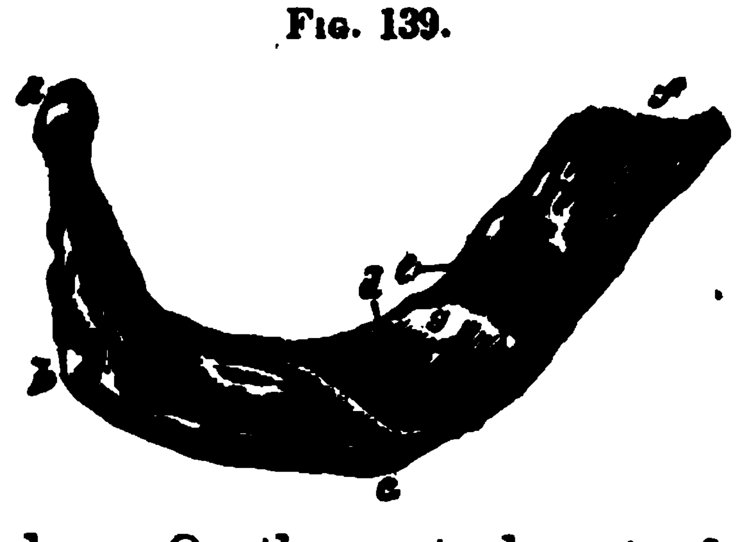


FIG. 139 represents the upper surface of the first Rib. *a* Head. *b* Tubercle. *c* Anterior surface. *d* Groove for subclavian artery. *e* Groove for subclavian vein. *f* Anterior extremity for cartilage. *g* Tubercle for scalenus anticus.

The second rib in some measure resembles the first in having little or no angle or twisting, and partly presenting upward. The tenth rib has but a single articular surface. The eleventh and twelfth have likewise but one articular face, have no neck, angle nor tuberosity, and are pointed at their extremity.

The ribs are spongy, with a thin covering of compact matter. Their *development* is from three points of ossification—one for the body, one for the head, and one for the tuberosity. Ossification begins in the body of the rib sooner than in the vertebræ. In the epiphysis it begins between the sixteenth and twentieth years; and complete union of all the parts takes place about the twenty-fifth year. Each rib *articulates* by its head, with two contiguous vertebræ, except the first and the last, which articulate each with a single vertebra; each unites also, by its sternal end, with the costal cartilage.

Cartilages of the Ribs.—The costal cartilages are of the permanent class, and are regarded as part of the skeleton of the chest. They are *situated* at the anterior extremities of the ribs, the seven uppermost of which they connect with the sternum. The first is short—the rest increase successively in length, to the seventh; and from this to the last they diminish, so that the twelfth has merely a tip of cartilage. The costal extremity of each cartilage is broader than the sternal. The depression in the end of the rib receives the former, while the cavities along the sides of the sternum, receive the latter. Their *anterior surface* is convex, and gives origin to the great pectoral muscle. The *posterior* is concave and lined partly by the pleura. Their margins, like the ribs, bound the intercostal spaces, and give attachment to the internal intercostals. The first costal cartilage is short, broad, and descends obliquely downward in the direction of the first rib; the second and third are nearly horizontal; the rest ascend more and more. The three superior cartilages of the false ribs are blended the one with the other, and the two lower, as already stated, are free and floating.

and situated on the posterior surface of the articulation.

The *superior* and *inferior costo-sternal ligaments* are simply narrow fasciculi of fibres, connecting the upper and lower margins of the sternal end of the costal cartilages with the sides of the sternum.

The cartilage of the first rib, it seems, has no synovial membrane, and is continuous with that of the sternum. The cartilage of the second rib, at its junction with the sternum, like the heads of the ribs, is divided by a ligamentous partition, forming two cavities and two synovial membranes. The sixth, seventh, and eighth, and occasionally the fifth and ninth, have articulations with each other lined by a synovial membrane. External and internal ligamentous fibres pass from one to the other. Ligamentous fibres are seen passing from the cartilage of the seventh rib near the sternum, and spreading themselves over the anterior surface of the xiphoid ligament, and are named *costo-xiphoid ligaments*. The motion of the ribs at the sternum is very limited.

GENERAL REMARKS UPON THE CHEST.

The *Chest* thus composed of the sternum, ribs, costal cartilages, and dorsal vertebræ, all bound together by the ligaments, presents a large and very important cavity for containing the lungs, the organs of respiration, and the heart, the chief agent of circulation.

This cavity, which in the skeleton is continuous with the abdominal, in the fresh subject is separated from the latter by the diaphragm. When the arms are detached from the trunk it presents the form of a truncated cone, having the apex above and the base below, flattened before and behind, and convex at the sides. This form of the chest, however, may be materially altered by tight lacing, and by disease. The anterior wall is, as already stated, shorter and more oblique than the posterior, which is vertical. Its surface is rendered very irregular by grooves, processes, and angles. The intercostal spaces are wider in front than

behind. The superior opening of the chest presents obliquely downward and forward, and is oval, its lateral diameter being the greatest. It gives passage to the trachea, œsophagus, vessels, nerves, muscles, cellular tissue, &c. The base of this cavity is represented by the diaphragm, the circumference of which is bounded by the xiphoid cartilage, the inferior margin of the cartilages of the false ribs, and the lower dorsal vertebræ.

The *dimensions* of the thoracic cavity vary according to age and in different individuals, and in the same individual according to the state of the diaphragm, whether ascending, descending, or quiescent. The capacity of the chest is intermediate between that of the abdominal and cranial cavity. Its diameters are three, the *antero-posterior*, *transverse*, and *vertical*. The *antero-posterior* has the greatest length below, and is shorter at either end than on the middle line, in consequence of the projection forward of the bodies of the vertebræ. The *transverse* is longest across the eighth ribs. The *vertical* has the greatest length of the three, and is longer at the sides than the middle, in consequence of the descent of the diaphragm.

During inspiration all these diameters are increased and the capacity of the chest enlarged in every direction, by the elevation of the ribs and the fall of the diaphragm. In expiration, on the contrary, these diameters are all lessened by the falling of the ribs and the ascent of the diaphragm, and the expulsion of air from the chest.

In the fœtus these motions do not, of course, take place, and the *form* of the chest is very different from that of the adult. The thoracic cavity is short, its sides compressed, and its base very broad, in consequence of the collapsed state of the lungs, and the great size of the liver.

The antero-posterior diameter is large, to provide for the heart and thymus gland, while on the sides it is comparatively small, on account of the unexpanded condition of the lungs. The vertical diameter is less, the ribs are closer together, and the intercostal spaces shorter. So soon, however, as respiration begins, the chest expands, and all the peculiarities just mentioned are lost.

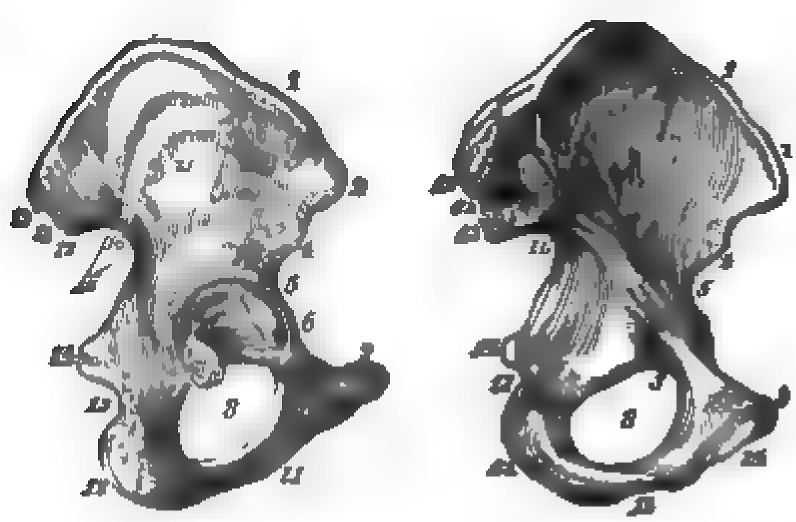
SECTION III.

THE PELVIS.

The *pelvis* is *situated* at the lower portion of the trunk, and is composed of four bones—the *sacrum*, *coccyx*, and two *ossa innominata*. The two former have been examined along with the spine. It only remains, therefore, to speak of the latter.

Os-innominatum.—This bone is *situated* at the lateral and anterior portions of the pelvis, and in the adult is composed of a single piece; but in the young subject consists of three: the *ilium*, *ischium*, and *pubis*.

A Fig. 142. B



The *ilium* is situated at the superior and outer portion of the pelvis, and is the largest of the three bones composing the innominatum. This bone is commonly called the *hip*, or *haunch bone*. It is somewhat triangular, broad and flat. It is divided into a *body*, *ala*, and *processes*. The body is the lower narrow portion, forming the upper and outer part of the acetabulum. It has, anteriorly, a

Fig. 142, A represents an exterior view of the *Os-innominatum*. 1 Crest of Ilium. 2 Anterior superior spinous process. 4 Anterior inferior spinous process. 5 Notch for the psoas-magnus, and iliacus internus. 6 Ileo-pubic spine. 8 Obturator foramen. 9 Angle of pubis. 11 Descending ramus of pubis. 12 Tuberosity of ischium. 13 Lesser sciatic notch. 14 Spine of the ischium. 15 16 Greater sciatic notch. 17 Posterior inferior spinous processes of ilium. 18 Rough surface. 19 Posterior superior spinous process. 21 Dorsum of the ilium.

Fig. 142, B represents an inner view of the *innominatum*. The figures 2 4 8 9 11 12 13 14 16 correspond to similar points as in Fig. A. 3 Groove for obturator vessels and nerves. 20 Posterior superior spinous process. 23 Posterior inferior spinous process. 22 Fissure between posterior processes. 21 Venter of ilium. 24 Symphysis pubis.

rough, triangular surface, for articulating with the pubis; and inferiorly and posteriorly, another for articulating with the ischium.

The *ala* is the broad portion which expands upward and outward from the body; it has two *surfaces* and a *circumference*. Its external surface is rough, and irregularly convex and concave, and is called the *dorsum*. This surface has two semicircular lines—a *superior* and *inferior*. The superior is long, usually well marked, begins a short distance behind the anterior superior spinous process, and takes a curved direction backward to the posterior part of the great sciatic notch. To this line, and all that part of the dorsum above, and between it and the upper edge of the ilium, with the exception of a small posterior portion, the *gluteus medius* muscle is attached. This excepted posterior part gives attachment to the *gluteus maximus*. The *inferior line*, a short distance above the acetabulum, curves backward from the anterior inferior spinous process to the fore part of the sciatic notch. To this line, and to the space between it and the superior line, the *gluteus minimus* muscle is attached. Below the inferior line, the body becomes prominent, and gives attachment to a part of the gluteus minimus—the external tendon of the rectus *femoris* muscle, and a portion of the capsular ligament.

The *internal surface* of the *ilium*, called the *venter*, has its central and superior part very concave for lodging the *iliacus internus* muscle; there is also seen upon it an oblique canal for the nutritious artery. Below the venter there is a rounded edge which is continuous with one from the promontory of the sacrum behind, and the pubis before, called the *linea-ileo pectinea*. All the surface above this line enters into the false pelvis. The small surface below it, and above the sciatic notch, helps to form the true pelvis.

The posterior part of this internal surface, is rough, and divided into two portions: the *anterior*, covered with cartilage, and articulating with the sacrum; and the posterior, rough for the attachment of the sacro sciatic-ligaments.

The *processes* of the ilium are seen upon its circumference. Its superior border is called the *crest*. In the young subject this is an epiphysis, and presents the form of an italic *S*, looking inward in front, and outward behind. The anterior extremity of the crest presents a projection called the *anterior superior spinous process*, which gives origin to the *sartorius* and *tensor vaginæ femoris* muscles, and *Poupart's ligament*.

The posterior extremity of the crest is the *posterior superior spinous process*, to which the sciatic ligaments are attached. The crest also has an inner margin, from which arises the *transversalis abdominis* muscle, an outer margin for the attachment of the *external oblique*, and an intermediate space for the *internal oblique*. The anterior circumference of the ilium presents a notch bounded above by the anterior superior spine, and below by the *anterior inferior* spine. This latter is above the outer part of the acetabulum and gives origin to the rectus femoris muscle. The notch has the gluteus medius attached to it, and an external cutaneous nerve occupying it. Below and internal to the anterior inferior spinous process, is a hollow, along which pass the *psoas magnus* and *iliacus internus* muscles; internal to this hollow and where the ilium unites with the pubis, is a prominence called the *ilio-pectineal eminence*. The posterior circumference, in addition to the posterior superior spinous process, has about an inch and a quarter below the *posterior inferior spinous process*. Below this spine the ilium becomes notched to form the sciatic notch.

The *ischium* (Fig. 142) is the next in *size* of the bones of the innominatum, and is *situated* at the lateral and inferior part of the pelvis. It is the bone on which we sit. It consists of a *body* and *processes*. The body presents a triangular or pyramidal form, and has three surfaces, an *internal*, *posterior*, and *external*. The internal surface, called the *plane* of the ischium, is smooth, broad above and narrow below. The *posterior* forms a prominent rounded surface, corresponding to the posterior parietes of the acetabulum. The *external surface* is much excavated and forms the lower

and outer part of the acetabulum. At this point the body contracts and presents a groove bounded above by the cotyloid ridge, along which the tendon of the obturator externus muscle passes. At the posterior part of the neck, just below the sciatic notch, is seen the *spinous process* which projects inward and backward, and to which is attached the *superior gemellus muscle* and the lesser sciatic ligament. Below this spine is a smooth pulley-like surface, round which turns the tendon of the *obturator internus*. As we descend, the next process is rough and large, and called the *tuberosity*—it is covered with cartilage, and presents three faces, one anterior, which gives origin to the semi-membranosus muscle; and two posterior, from which the semitendinosus and biceps arise. To the outer margin, the *adductor magnus*, *quadratus femoris*, and *gemellus inferior* are attached; to the inner, the long sacro-sciatic ligament. Between the spine and the tuberosity is the *lesser sciatic* notch, converted into a foramen by the long sciatic ligament. From the tuberosity the *ramus* ascends forward and inward to unite with the pubis, and bounds the inferior and internal portion of the thyroid foramen. It is a flat process, its surfaces presenting, externally and internally. Its anterior border bounds, in part, the lower outlet of the pelvis.

The *os-pubis* (Fig. 142) is smaller than either the ilium or ischium, and is situated at the front part of the pelvis; it consists also of a *body* and *processes*. The most external portion is regarded as the body; it is thick, and forms the internal and upper part of the acetabulum. Its lower portion unites with the body of the ischium; its upper joins the ilium in the ilio-pectineal eminence. Its inner surface is smooth, and enters into the formation of the anterior pelvic wall. From the body proceeds, transversely inward and forward, a process called the *horizontal ramus*. The superior surface of this ramus is smooth, and bounded internally by a process or tuberosity, called the *spine* of the pubis, which gives insertion to Poupart's ligament. From this spine proceed outward two ridges; the posterior is the more elevated and frequently sharp, called the *crista*,

and forms the anterior portion of the *linea ilio-pectinea*, to which is attached Gimbernat's ligament and the fascia lata. The anterior ridge is more round, and ends at the upper margin of the acetabulum. Between the two ridges is situated the *pectineus muscle*. Internal to the spine of the pubis is the *crest*, leading transversely to the median line, and about an inch in length. It gives attachment to the *rectus abdominis* and *pyramidalis* muscles, and to the united tendons of the *internal oblique* and *transversalis*. From the crest there is an inferior or descending portion called the *symphysis* and *descending ramus*. The symphysis is vertical and rough, and forms with the crest the *angle* of the pubis. It meets its fellow of the opposite side by an intermediate substance of fibro-cartilage. The *ramus* goes backward and outward to meet the ramus of the ischium, and its outer edge bounds the thyroid foramen, while its inner edge gives attachment to the crus of the penis or the clitoris. The space between the rami on either side and below the symphysis describes a curve called the *arch* of the *pubis*.

The *innominatum*, composed of three bones, presents at their common point of junction a deep, hemispherical cavity, the *acetabulum* or *cotyloid cavity*. The ilium forms a little less than two-fifths, the ischium a little more than two-fifths, and the pubis about one-fifth of this cavity. It is bounded by a deep notch internally, which is converted, by a ligament stretched across from the pubis to the ischium, into a foramen, through which pass the articular vessels. The superior and outer part of this cavity is smooth, covered with cartilage, and receives the head of the thigh bone. The central portion and the part leading from it to the notch, is rough, gives attachment to the *ligamentum teres*, and contains a quantity of soft adipose matter.

In the front of the innominatum and to the inside of each acetabulum are seen two large *foramina*, called the *obturator* or *thyroid*. These are formed by the ischium and pubis. The edge of this opening is thin and has superiorly a groove for the passage of the obturator vessels and nerve.

The rest of the opening is filled by the obturator ligament.

The *structure* of the innominatum is cellular internally, with a compact layer externally.

Its *development* is from three principal centres of ossification, one for the ilium, one for the ischium, and one for the pubis, all of which meet in the acetabulum; and five additional or secondary points are noticed, one for the crest of the ilium, one for the tuberosity of the ischium, one for the anterior and inferior spine of the ilium, one for the angle of the pubis, and one for the centre of the acetabulum. These latter points appear at the twelfth year. Ossification is noticed first in the ilium, at the same time or soon after it occurs in the vertebræ; about the third month in the ischium, and between the fourth and fifth months in the pubis, about the sixth year the rami of the ischium and pubis are found nearly ossified, and join in the tenth year. The three bones are complete in the acetabulum by the twenty-fifth year.

The osinnominatum articulates with its fellow, the sacrum and the head of the femur.

LIGAMENTS OF THE PELVIS.

The mode of articulation between the last lumbar vertebra and the sacrum, is the same as those of the other vertebræ already described; by the intervertebral, anterior and posterior, capsular, yellow, supra spinous, and interspinous ligaments, and synovial membranes. There is however an additional ligament, consisting of a short, thick, strong fasciculus extending from the transverse process of the last lumbar vertebra to the posterior superior part of the base of the sacrum, called *lumbo-sacral ligament.* The next ligament connecting the vertebral column to the pelvis is the *ilio-lumbar.* It arises from the transverse processes of the two lower lumbar vertebræ, and is inserted into the posterior crest of the ilium and into its posterior superior spinous process. The ligaments of the pelvis are those connecting the sacrum and ilium, those connecting the sacrum, coc-

cyx, and ischium, those binding the ossa-pubis together, and those uniting the sacrum and coccyx.

Fig. 143.

The *sacro-iliac articulation* consists of anterior and posterior sacro-iliac ligaments.

The *anterior sacro iliac ligament* is a thin sheet of fibres passing from the ilium to the sacrum on the anterior surface of the joint.

The *posterio sacro-iliac ligament* is much stronger than the anterior, and forms the chief bond of union between the sacrum and ilium. It consists of numerous strong ligamentous fasciculi extending transversely and obliquely from the rough surface of the sacrum to the rough surface of the ilium, and to its posterior superior spine. This latter attachment receives the name of *sacro-spinous ligament.*

The articular surfaces of the sacrum and ilium are covered with cartilage, and have an imperfect synovial membrane, more readily distinguished in the young than in the adult, and occasionally lubricated with fluid.

Sacro-ischiac articulation. The sacrum and coccyx are united to the ischium by two ligaments, the *anterior* and *posterior sacro-sciatic.*

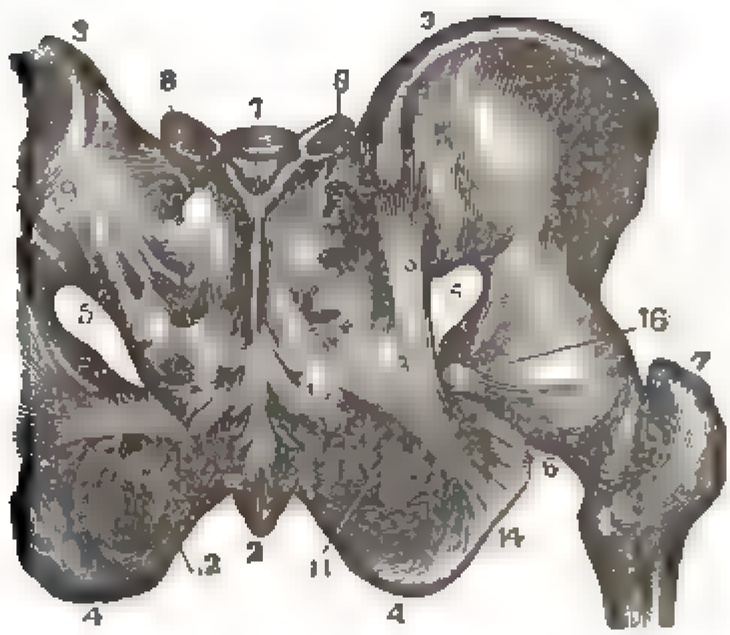
The *anterior or lesser sacro-sciatic ligament arises* broad and thin from the side of the sacrum and coccyx, crosses the other, and has a narrow insertion into the spine of the ischium. Its pelvic portion is connected with the coccygeus muscle.

The *posterior or great sacro-sciatic ligament* is much larger,

Fig. 143 represents a front view of the Ligaments of the Pelvis. 1 Anterior vertebral ligament, its lower end. 2 Sacro-vertebral ligament. 3 Ileo-lumbar ligament. 4 Sacro-iliac ligament, its anterior portion. 5 Obturator ligament. 6 Poupart's ligament. 7 Gimbernat's ligament. 8 Capsular ligament of hip-joint. 9 Accessory ligament of hip-joint.

longer and thicker than the anterior, and arises from the posterior inferior spinous process of the ilium, and the side of the sacrum and coccyx. It is inserted by a broad attachment into the inner margin of the tuberosity of the ischium, which is traced forward in the shape of a falciform process, upon the ramus of the ischium, and serves to shield the internal pudic vessels and nerves. Posteriorly, it is covered by the *gluteus maximus muscle*, to some of the fibres of which it gives origin. These ligaments are of use in forming the lower and lateral parietes of the true pelvis. By their crossing they convert the ischiatic notches into foramina, the larger and *superior* giving passage to the *pyriform* muscle, the *gluteal* and *sciatic vessels* and *nerves*, while the smaller and *inferior* transmit the internal pudic vessels and nerve, and the tendon of the *obturator internus* muscle.

Fig. 144.



Articulation of the ossa pubis.—The two ossa pubis are united, along the median line, by an *intermediate fibro-cartilage.* Its fibres assume the form of concentric laminæ, some of which are continued all round, while others are interrupted; some take the oblique course, and cross each other. This articulation resembles, in some degree, the intervertebral, and sometimes contains, in its centre, a

Fig. 144 represents a posterior view of the Ligaments of the Pelvis. 1 Base of sacrum. 2 Coccyx. 3 3 Crest of ilium. 4 4 Tuber ischii. 5 5 Greater sciatic notch. 6 Lesser sciatic notch. 7 Femur. 8 8 Sacro-iliac ligaments, posterior portion. 9 Sacro-spinous. 10 Posterior-sacro-coccygeal ligament. 11 Obturator ligament. 12 Obturator foramen. 13 13 Upper attachment of the greater sacro-sciatic ligament. 14 Its lower attachment. 15 16 The two attachments of the lesser sciatic ligament.

pulpy or viscid fluid. At its posterior portion, a delicate synovial membrane has occasionally been seen.

The *anterior pubic ligament* consists of fibres passing in front of the symphysis, from the one side to the other.

The *posterior pubic ligament* is made up of a few fibres on the posterior surface of the symphysis.

The *sub-pubic*, or *inter-pubic ligament*, is situated beneath the symphysis to which it is connected. Its *form* is triangular, about half an inch broad, and consists of a strong, compact layer of fibres, passing from the crus of the pubis, on the one side, to a similar point on the opposite, rounding off the angle or arch of the pubis. The triangular ligament of the urethra is below this sub-pubic ligament.

The *superior pubic ligament* consists of a plane of fibres uniting the angles of the pubis.

The *obturator ligament* closes the obturator foramen, and consists of a thin fibrous membrane, which is attached all round to the edge of this opening, except at its superior part, where the obturator vessels and nerve pass. Its outer and inner surfaces respectively give attachment to the *external* and *internal obturator muscles*. The *articulation* of the *sacrum* and *coccyx* has been described under the ligaments of the spine.

GENERAL REMARKS UPON THE PELVIS, AS A WHOLE.

The *pelvis*, as we have seen, consists of the two ossa innominata, the sacrum and coccyx. These are divided on the interior by the *linea ilio-pectinea*, into the *false* and the *true* pelvis. All above this line, as high as the top of the ilium, is the false pelvis; all below is the true, and this line of separation between the two is called the *superior strait*. The cavity of the pelvis presents the form of a flat truncated cone, the base above, the apex below. It contains some of the viscera of the abdomen, while it and its parietes receive and support the organs of generation, and part of the urinary organs, at the same time furnishing attachment for many muscles.

The upper or false pelvis is the base of this cone. In the

dry skeleton it is deficient in front, but in the fresh subject it is closed in by the abdominal muscles. The alæ of the ilia constitute its lateral and superior boundaries.

The lower or true pelvis is a perfect bony canal, deeper however, at the sides and behind, than in front; the sacrum and coccyx forming its posterior wall, the ischia and part of the ilia its sides, and the pubis completing it in front. The true pelvis has two orifices, an upper and lower, called the *superior* and *inferior straits*, or outlets of the pelvis. The superior strait looks forward and upward, and its axis may be represented by a line drawn from the point of the coccyx to about an inch below the umbilicus. The inferior strait or lower outlet is smaller than the upper, and in the fresh subject is much smaller still, owing to the closing of the sciatic notches, which limits the opening to the space between the arch and rami of the pubis and the coccyx. The opening of the lower strait looks downward and forward, and its axis is marked by a line passing through its centre and striking the lower part of the first bone of the sacrum; so that it will be seen that the perpendiculars to the planes of the two straits have different directions, and decussate or cross each other about the centre of the pelvis, forming an obtuse angle looking forward. The axis of the pelvis describes a curve, the upper strait looking downward and backward, the lower strait downward and forward, important practical points to recollect in parturition and in the operation for stone.

DIFFERENCES BETWEEN THE MALE AND FEMALE PELVIS.

The *female pelvis* differs from the male in several points. It is larger, the alæ of the ilia are wider apart, more expanded and not so concave; the depth of the pelvis is not so great. The upper and lower straits are both wider and rounder; the sacrum is shorter, more concave, and wider; the promontory of the sacrum is less; the rami of the pubis are farther apart, but not so long as in the male; and the arch of the pubis is regularly rounded and smooth, whereas in the male it forms an acute angle. The cartilage at the

symphysis pubis is thicker in the female, the tuberosities are further apart, and the acetabula more distant from each other. All the bones of the female pelvis are more delicate, rounder, and thin; and its diameters are greater than those of the male.

The average diameters of the female pelvis are given as follows—(Fig. 145.) In the superior strait there are three, the *antero-posterior*, *transverse*, and *oblique*.

The first extends from the middle of the promontory of the sacrum to the superior part of the symphysis pubis, and measures about four inches. The second, or *transverse*, extends from the central part of the superior strait, on the one side, to a similar point on the opposite, and measures about five inches. The third, or *oblique* diameter, measures about four and a half inches, and reaches from the *sacro-iliac* junction to the opposite ilio-pectineal eminence.

Fig. 145.

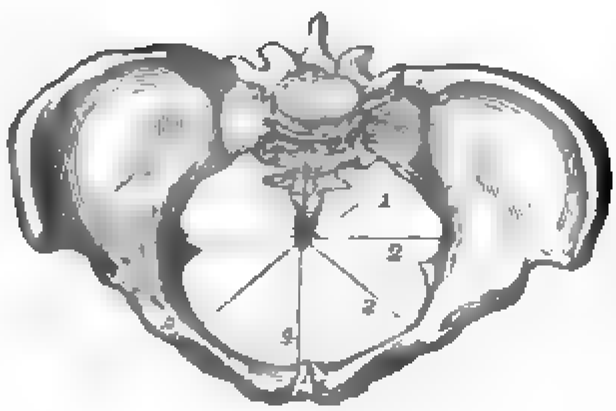


TABLE OF MEASUREMENTS OF THE MALE AND FEMALE PELVIS, BY MECKEL.

	MALE.		FEMALE.	
	In.	Lines.	In.	Lines.
Transverse diameter of great pelvis between anterior and superior spinous processes of ilia,	7	8	8	6
Distance between crista of ilia,	8	3	9	4
Transverse diameter of superior strait,	4	6	5	
Oblique diameter of superior strait,	4	5	4	5
Transverse diameter of the cavity,	4		4	8
Oblique diameter of the cavity,	5		5	4
Antero-posterior diameter of the cavity,	5		4	8
Transverse diameter of lower strait,	3		4	5
Antero-posterior diameter of lower strait,	3	3	4	4

This latter diameter, from the mobility of the coccyx in the female, can be increased to five inches.

Fig. 145 represents the average diameters of the superior Strait of the female Pelvis. 1 3 Oblique diameters. 2 Transverse. 4 Antero-posterior or sacro-pubic diameter.

CHAPTER II.

ACTIVE ORGANS OF THE TRUNK.

FIRST DIVISION.

ORGANS BELONGING TO THE NECK AND BACK.

1. Organs of motion—the muscles.
2. Organ of deglutition—œsophagus.
3. Organs of circulation—blood-vessels.
4. Organs of innervation—nerves.
5. Thyroid gland.
6. Lymphatic glands.
7. Fascia of the neck.
8. Organ of voice.

SECTION I.

ORGANS OF MOTION—MUSCLES OF ANTERIOR NECK.

Dissection.—Make an incision through the integuments along the clavicle, from the sternum to the acromion process; a second incision from the chin, along the margin of the lower jaw, to the mastoid process; connect these two by a third, running along the median line of the neck, from the chin to the sternum. The integument, thus marked off, should be dissected from the chin, obliquely downward and outward towards the clavicle, embracing the whole side of

FIG. 146.

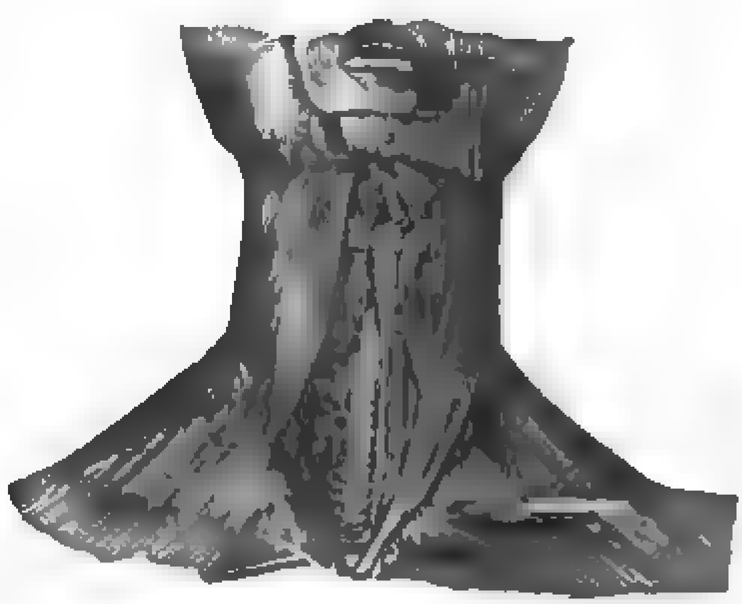


FIG. 146 represents the superficial Muscles of the Neck. *a* Platysma myoides, or latissimus colli. *b* Sterno-cleido mastoideus. *c* Sternal attachment. *d* Clavicular attachment. *e* Sterno-hyoideus.

the neck. This brings to view the superficial fascia, the removal of which exposes the first superficial muscle.

The *platysma myoides*, (πλατυς, μυς, ειδος, broad *muscle-like lamella*) or *latissimus colli*, consists of a very delicate, thin, pale, and broad plane of muscular fibres, situated between two layers of the superficial fascia. It is a cutaneous muscle corresponding to the *panniculus carnosus* of quadrupeds.

It *arises* below the clavicle from the cellular tissue and integument covering the pectoral and deltoid muscles, and then ascends obliquely inward upon the side of the neck, to be *inserted* into the cellular tissue and skin of the chin, where it intersects fibres from the opposite side, and into the fascia of the lower jaw. Its fibres are frequently traced upward, intermingling with the muscles at the angle of the mouth, and backward to the fascia covering the parotid gland. From this gland a transverse band of fibres, *risorius santorini*, have been traced to the angles of the mouth.

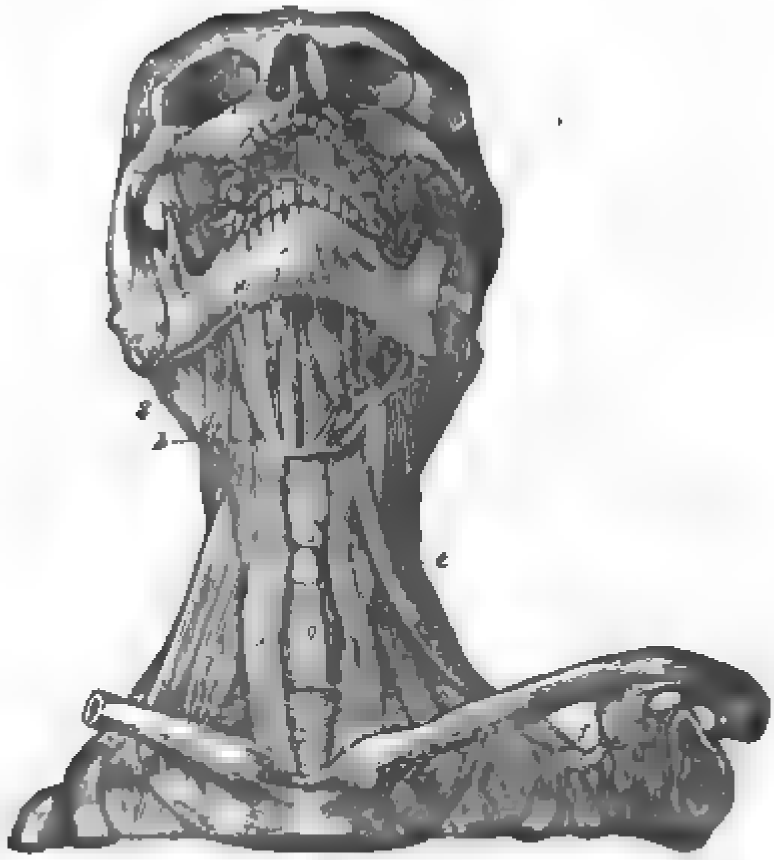
Function.—To depress the lower jaw and angles of the mouth, and if the mouth be closed to raise the skin upon the neck. It covers and supports the muscles, vessels and glands beneath, and has the external jugular vein partly imbedded in its substance.

Sterno-cleido mastoideus (Fig. 146) is situated at the lateral and anterior part of the neck, enclosed between two layers of the cervical fascia. It *arises* from the sternum by a strong flat tendon, and from the sternal third or half of the clavicle by a broad, fleshy and aponeurotic origin. These two origins of this muscle include a small space of triangular shape, containing small vessels and cellular substance. The sternal portion is the larger, and as it ascends, overlaps the clavicular which proceeds vertically. About the middle of the neck the two are united, and thence go to be *inserted* into the *mastoid* process by a thick, round tendon, and by an aponeurosis into the outer portion of the superior transverse ridge of the occipital bone.

Function.—Both muscles acting together will bend the

head forward. If the sternal portion act alone it will turn the face to the opposite side; if the clavicular act by itself it will bend the head to the same side. If the muscles of the back be in strong action, this muscle can assist in still further throwing the head backward, as seen in that variety of tetanus called opisthotonos. It is concerned in the production of wry neck. It has in front or covering it, the skin, platysma, superficial fascia, external jugular vein, portion of the parotid gland, branches of the portio-dura, and cervical plexus of nerves, and at its upper part it is perforated by the spinal accessory nerve, which, however, sometimes passes behind it.

FIG. 147.



The *sterno-hyoideus* is a long, narrow, flat muscle, situated on either side of the median line of the neck, and exposed by removing the deep cervical fascia. It *arises* from the first bone of the sternum on its posterior surface, and the sternal end of the clavicle, ascends and is *inserted* into the inferior margin of the body of the os-hyoides.

FIG. 147 represents the principal muscles of the neck, after turning aside the platysma myoides. *a* Mastoid process. *b* Hyoid bone. *c* Sterno hyoideus muscle. *d* Sterno thyroideus. *e* Omo hyoideus. *f* Origin of omo-hyoideus. *g* Thyroid gland. *h* Anterior belly of digastricus. *i* Posterior belly of the same. *j* Where the digastric tendon passes through the stylo-hyoideus. *k* Mylo-hyoideus. *l* Genio-hyoideus. *m* Hyo-glossus. *n* Thyro-hyoideus. *o* Thyroid cartilage. *p* Scalenus anticus. *q* Rectus capitis-anticus major. *r* Levator anguli scapulæ. *s* Splenius.

Function.—To draw down the *os-hyoides*, *pharynx*, and *larynx*. It is covered by the sternum, clavicle, and sterno-mastoid muscle at its lower portion.

The *sterno-thyroideus* is situated beneath the last, and is broader and shorter, being ribbon-like in its appearance. It *arises* from the back part of the upper bone of the sternum and the cartilage of the first rib, ascends obliquely, and is *inserted* into the ala of the thyroid cartilage, upon its oblique line.

Function.—To draw down the larynx. It is covered by the sterno-hyoid and mastoid muscles.

The *omo-hyoideus* (ὦμος, shoulder,) is situated obliquely across the neck, and is a long, narrow, and double-bellied muscle. It *arises* from the superior costa of the scapula, posterior to its semi-lunar notch, and from the ligament of this notch by a fleshy origin. It occasionally arises from the acromial end of the clavicle, and base of the coracoid process. It ascends above the clavicle and passes behind the sterno mastoid muscle, where it becomes tendinous. After this it again becomes fleshy and is *inserted* into the inferior border of the os-hyoides, at the junction of its body and cornu.

Function.—To draw the os-hyoides downward and backward, and assist in deglutition. Its origin is concealed by the trapezius; it crosses the carotid artery and internal jugular vein, and its insertion is covered by the fascia and integuments.

The two *sterno-mastoid* muscles, with the *omo-hyoid*, and the anterior edge of the *trapezius*, to be presently noticed, form several triangles very important in a surgical point of view, and recognizable in the living subject.

The two sterno-mastoid muscles, coming together at the sternum, form the apex of a large triangular space on the front of the neck, the sides of which are formed by the divergence of these same muscles, to the mastoid processes, while the base of this triangle is above, and constituted by the lower jaw. The median line of the neck divides this triangle into two, called the *anterior lateral triangles* of the neck.

On the outside of the mastoid muscle, and between its posterior edge and the anterior edge of the trapezius, there is another triangular space, having its base below, resting on the clavicle—its apex above, at the mastoid process, where the muscles meet, while its sides are formed by the same muscles. This space is called the *posterior lateral triangle* of the neck.

Each of these large triangular spaces is crossed by the omo-hyoideus muscle, which divides each of them into two, and consequently makes four triangles on each side of the median line of the neck. These are named as follows: 1. *Anterior superior.* 2. *Anterior inferior.* 3. *Posterior superior.* 4. *Posterior inferior.*

Of these triangles, the anterior superior and posterior inferior seem, practically, the most important, as in the former we tie the carotid artery, and in the latter, the subclavian. It may be well here to notice the contents of each of these triangles.

The *anterior superior triangle* is situated between the anterior belly of the *omo-hyoid*, and the *sterno mastoid*, the apex of the triangle being formed by the intersection of these muscles opposite the cricoid cartilage, and the base, which is superior, by the digastric muscle. The *carotid artery*, the *internal jugular vein*, the *par-vagum*, and the *sympathetic nerves*, are found in this triangle, simply covered by the fascia, the platysma, and the integuments.

The *anterior inferior triangle* is situated below the anterior belly of the omo-hyoid, and between it and the median line of the neck, above the sternal end of the clavicle; it also contains the *carotid artery*, the *jugular vein*, and the accompanying *nerves*, and is covered by the sterno-mastoid, sterno-hyoid, and sterno-thyroid muscles. A portion of the thyroid gland is also seen in this triangle.

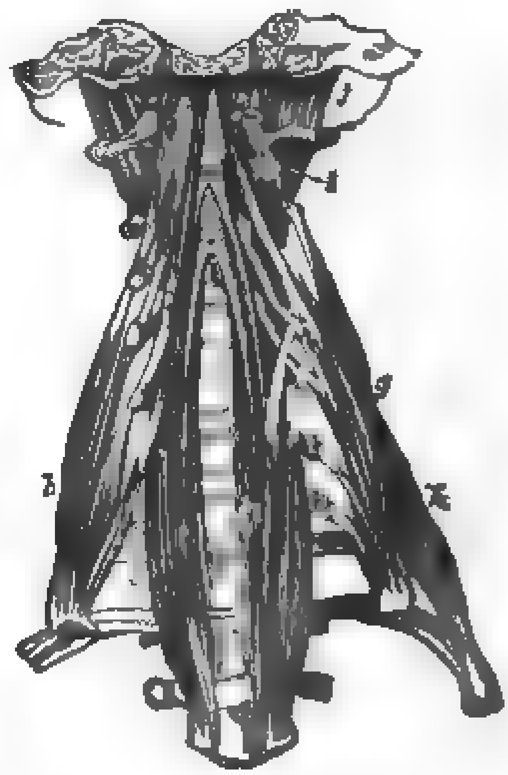
The *posterior superior triangle* is between the trapezius and sterno-mastoid, and above the posterior belly of the omo-hyoid muscle; it contains cellular tissue, lymphatic glands, and the cervical plexus of nerves.

The *posterior inferior triangle* is below the posterior belly

of the omo-hyoid, above the clavicle, and behind the posterior inferior margin of the sterno-mastoid. The *sub-clavian artery* and some of its branches, with the *vein* and *brachial plexus* of nerves, are seen in this triangle.

The *scalenus anticus* muscle is situated at the lower and anterior part of the neck, and is considered to be continuous with the rectus capitis anticus major. It *arises* tendinous from the third, fourth, fifth, and sixth transverse processes of the cervical vertebræ, and is *inserted* into the superior surface of the first rib at its sternal end.

Fig. 148.



The *scalenus medius* is larger than the last and *arises* from the transverse processes of all the cervical vertebræ by tendinous fibres. Sometimes it originates only from the four or five lower cervical vertebræ. It is *inserted* into the superior surface of the first rib posterior to the subclavian artery.

The *scalenus posticus* is behind the former, and is better seen in dissecting the muscles of the spine. It *arises* from the transverse processes of the two or three lower cervical vertebræ, and is *inserted* into the superior surface of the second rib between its tubercle and angle. The two last muscles are by some regarded as a single one, and described as such.

Function.—The three scaleni bend the neck forward or to one side, and when the vertebræ are fixed, elevate the ribs. The first scalenus has the phrenic nerve descending on the front, the *subclavian vein* crossing its insertion, the *sub-*

Fig. 148 represents the deep Muscles of the anterior Neck. *a* Rectus capitis anticus major. *d* Rectus capitis anticus minor. *j* Rectus capitis lateralis. *b* Scalenus anticus. *g* Scalenus medius. *h* Scalenus posticus. *c f* Longus colli—its lower portion on the right side, and upper portion on the left side. *i* One of the intertransversales.

clavian artery and *brachial* plexus behind it, and the sterno-mastoid and omo-hyoid muscles in front.

The second scalenus or medius has the subclavian and brachial plexus in front, and is covered by the first.

The *longus colli* is situated close upon the bodies of the vertebræ, upon either side of the median line. It *arises* from the bodies of the three superior dorsal vertebræ at their sides, and from the transverse processes of the lower cervical vertebræ, and also occasionally by a slip from the first and second rib. Its *insertion* is into the front of the bodies of the cervical vertebræ.

Function.—To bend the neck directly forward and to the one side. The division of this muscle into a superior and inferior portion, has led to some apparent discrepancy among anatomists, as to its origin and insertion, though there is general uniformity as to its several attachments.

Upon this muscle rests the pharynx, œsophagus, and the great cervical vessels and nerves with their sheaths.

Rectus capitis anticus major.—At the superior and anterior part of the neck there are three recti muscles, the *major*, *minor*, and *lateralis.*

Dissection.—These are deep muscles, and are seen along with the longus colli, on the removal of the œsophagus and pharynx.

The *rectus capitis anticus major arises* tendinous from the transverse processes of the four lower cervical vertebræ. The four tendons ascend, and becoming fleshy, proceed obliquely inward, forming a broad and thick muscle, which is *inserted* into the cuneiform process of the occipital bone, just in front of the condyle.

Function.—To bend the head and also the neck *forward.*

Rectus capitis anticus minor is a small and narrow muscle. It *arises* from the front of the atlas near its transverse process, and is *inserted* into the cuneiform process of the occipital bone, beneath the rectus major.

Function.—To bend the head forward and to one side. The superior cervical ganglion of the sympathetic rests in part upon this muscle.

Rectus capitis lateralis arises from the transverse process of the atlas, and is *inserted* into the jugular eminence of the occipital bone on the outside of its condyle. It is a very short muscle, and its *function* is to bend the head to the one side. It covers the vertebral artery and has the jugular vein resting upon it.

SECTION II.

ORGANS OF MOTION, OR MUSCLES ON POSTERIOR NECK AND BACK.

Dissection.—Raise the chest by placing a block beneath it, and let the arms and head hang, so as to make the muscles and integument tense. Commence an incision from the external occipital protuberance, which carry along the spinous processes to the coccyx. Make a second from the lower cervical spine, to the acromion process; and a third from the occipital protuberance, along the superior transverse ridge, towards the mastoid process. Commence the dissection at the second incision, and raise the skin upward and downward, dissecting always in the course of the fibres of the muscle, and taking care to take off the cellular structure, along with the integument, so as to leave the muscles clean and distinct. The muscles of the posterior neck and of the back have been divided into six layers.

The first layer is superficial, and consists of two muscles, the *trapezius* and *latissimus dorsi.*

The *Trapezius*, so called from its resemblance to the mathematical figure of that name, is a triangular, broad muscle, having its base at the spine, and apex at the acromion process of the scapula. It is situated on the back part of the neck and chest, and *arises* from the external occipital protuberance and its superior transverse ridge, by a thin aponeurotic tendon; also from the spinous processes of the five superior cervical vertebræ, by the ligamentum nuchæ; and again tendinous from the spinous processes of the two lower cervical, and all the dorsal. The superior fibres descend, the inferior ascend, and the middle run transversely, all converging towards the shoulder, to be

inserted into the outer third of the clavicle, the acromion process, and the superior edge of the spine of the scapula.

Function.—To draw the shoulder toward the spine. Its superior fibres can also raise the shoulder, while the inferior can depress it. The head can also be inclined backward and to the one side by it.

Fig. 149.

The *ligamentum nuchæ* is composed of cellulo-ligamentous matter, broad above, extending from the external occipital protuberance along the median line, and attached to the spinous processes of all the cervical vertebræ. It forms a complete partition between the muscles upon the two sides of the neck. It is very powerful in the ox, and is of great use in supporting the head and in giving attachment to muscles.

The *latissimus dorsi*, as its name implies, is truly the broad muscle of the back. It is situated immediately beneath the skin, covering the whole of the lower part of the back and loins, and *arises* by a thin tendinous membrane, from the six inferior spines of the back, and by the *fascia lumborum*, from all the spines of the loins and sacrum; also

Fig. 149 represents the Superficial Muscles of the back and neck. 1 Trapezius. 2 Latissimus-dorsi. 3 Infra-spinatus. 4 Teres minor. 5 Teres major. 6 Obliquus externus. 7 Serratus magnus. 8 Pectoralis major. 11 Sterno-mastoid. 12 Deltoid. 16 Gluteus maximus.

from the posterior third of the crest of the ilium, and by fleshy slips from the three or four lower ribs. The fibres from this extensive origin converge towards the axilla, so as to form its posterior fold, and thence go to be *inserted* by a broad, thick tendon, into the lower part of the posterior edge of the bicipital groove of the humerus. As this muscle ascends, it passes over the inferior angle of the scapula, where a bursa is found interposed, and where also a fasciculus of fibres often connects the two. At this point it is behind the *teres major*, but as it proceeds it winds around this muscle so as to get in front. The two tendons are closely connected, but separated by a bursa.

Function.—To draw the arm downward and backward. It can also depress the shoulder and rotate the humerus inwards, and if the shoulders be fixed it can elevate the ribs and assist in inspiration.

The second layer consists of three muscles.

Rhomboideus minor.—Dissection.—Cut through the trapezius along its spinal attachment, and reflect towards the shoulder, which will expose the rhomboidei. This is a narrow muscle, and seems more properly to form a part of the next, the *rhomboideus major*, with which it is so intimately blended. It *arises* by a thin tendon from the two or three lower cervical spines, passes obliquely down and is *inserted* into the base of the scapula opposite its spine.

The *rhomboideus major arises* tendinous from the four superior dorsal spines, passes down parallel and in connection with the rhomboideus minor, and is inserted into all the base of the scapula from its spine to the inferior angle. These two muscles receive their name from their quadrilateral figure.

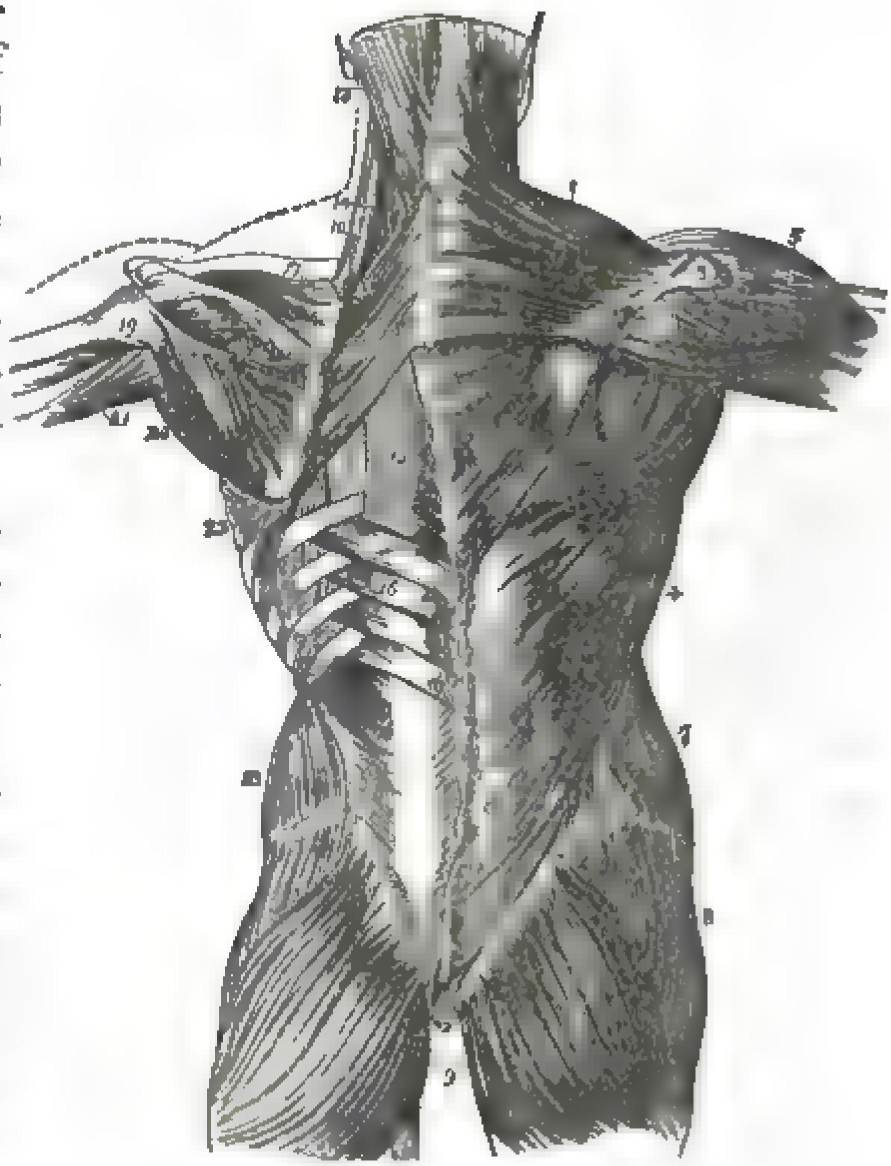
Function.—To draw the shoulder backward and upward toward the spine.

The *levator anguli scapulæ* is *situated* at the upper and posterior side of the neck, between the anterior margin of the trapezius and the posterior margin of the sterno-cleido-mastoideus. It *arises* by distinct and rounded tendons from the transverse processes of the four or five superior cervical

vertebræ; these unite to form a fleshy belly, which is *inserted* into all the base of the scapula from its spine to the superior angle.

Function.—To raise the shoulder, when acting with the trapezius. When acting by itself it elevates the superior angle of the scapula, and in proportion depresses the acromion.

FIG. 150.



Third layer.—*Dissection.*—Remove the rhomboidei by detaching them from the base of the scapula, and the latissimus dorsi, by dividing along its centre and reflecting towards the spine, and the third layer is exposed, which consists of the three following muscles:

The *serratus posticus superior*, situated at the upper and

FIG. 150 represents the Muscles of the Back, seen after removing the superficial set. 1 Trapezius. 2 Tendon of the two trapezii. 3 Spine of scapula. 4 Latissimus dorsi. 5 Deltoid. 6 Infra-spinatus, teres-minor. 7 External oblique. 8 Gluteus medius. 9 Gluteus maximus. 10 Levator scapulæ. 11 Rhomboideus minor. 12 Rhomboideus major. 13 14 Splenius capitis et colli. 15 Origin of latissimus dorsi. 16 Serratus posticus inferior. 17 Supra spinatus. 18 Infra-spinatus. 19 Teres minor. 20 Teres major. 21 Long head of triceps extensor cubiti. 22 Serratus major anticus. 23 Internal oblique.

back part of the chest, *arises* by a thin aponeurotic tendon, from the ligamentum nuchæ, the three inferior spines of the neck, and from the two or three superior spines of the back, and is *inserted* by fleshy digitations into the upper edges of the second, third, and fourth ribs.

Function.—To elevate the ribs, and thus, by expanding the chest, to assist in inspiration.

The *serratus posticus inferior*, situated at the lower and back part of the chest, is a broader and thinner muscle than the last. It *arises*, by a very delicate tendinous expansion, beneath the latissimus dorsi, with which it is strongly connected, through the fascia lumborum; from the spinous processes of the two lower dorsal, and two or three upper lumbar vertebræ, and is *inserted*, by fleshy digitations, into the inferior margins of the four lower ribs.

Function.—To depress the ribs, and thus by lessening the capacity of the chest, to assist in expiration. It is the antagonist muscle of the superior serratus.

The *splenius capitis et colli* has its lower portion concealed by the muscle before the last; and its upper, by the trapezius. It *arises* from the four or five superior spines of the back, and the three or four lower of the neck, and from the ligamentum nuchæ; it ascends as a long, flat, and fleshy muscle, and is *inserted*, by two distinct portions—one for the head—into the *mastoid process* of the temporal bone, and the surface between the two semicircular ridges of the occipital; and the other, for the neck, into the transverse processes of the two or three superior cervical vertebræ.

Function.—To bend the head and neck backward.

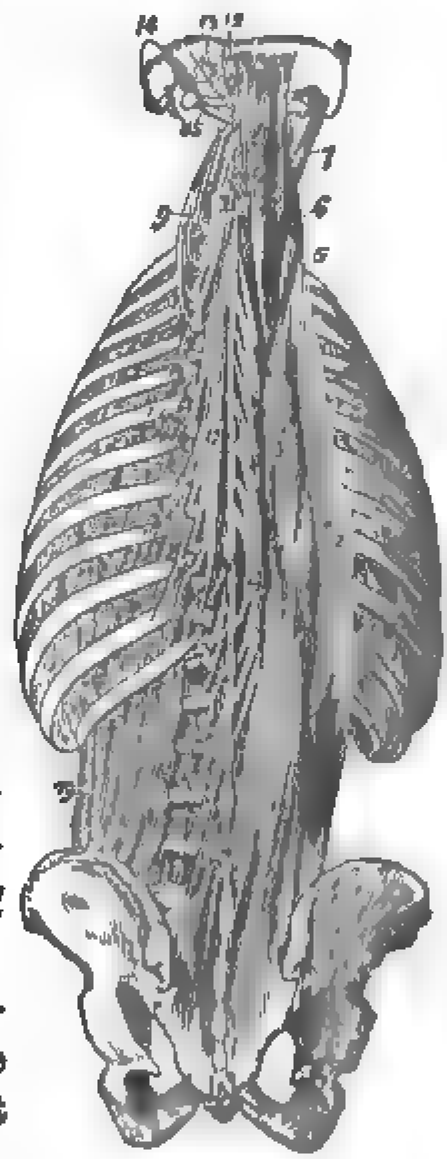
The *fourth layer* is seen by removing the serrati and splenii, and consists of the following seven muscles:

Sacro-lumbalis, *longissimus dorsi*, *spinalis dorsi*. These three muscles are associated under the name of *erector spinæ*. The whole appear as one mass, occupying the space between the spinous processes and the angles of the ribs.

The first two have a common *origin* from the posterior surface of the sacrum, from the posterior third of the crest of the ilium, and from the spinous and oblique processes of

the lumbar vertebræ; on a level with the last rib a division occurs. The *sacro-lumbalis* forms the outermost and larger portion, and is *inserted* by long and slender tendons, into all the ribs at their angles.

FIG. 151.



The *longissimus dorsi* is nearest the spine, and is *inserted* by short tendons into the transverse processes of all the dorsal vertebræ, and by tendinous and fleshy slips into all the ribs between their tubercles and angles.

Function.—These two muscles extend the spine, and preserve it in the erect state. On separating these muscles, six or eight tendinous and fleshy slips are seen coming from the superior margin of the ribs and attaching themselves to the lower surface of the sacro-lumbalis; they are called the *musculi accessorii ad sacro-lumbalem.*

The *spinalis dorsi* is a purely tendinous muscle, *situated* along the edges of the spinous processes. It *arises* tendinous from the two superior lumbar and three inferior dorsal spines, and is *inserted* tendinous into the nine upper dorsal spines. *Function.*—The same as the two last. These three muscles are covered by the *fascia lumborum.*

The *cervicalis ascendens* or *descendens*, appears to be a continuation of the sacro-lumbalis. It arises from the upper

FIG. 151 represents the deep Muscles of the back and neck. 1 3 Longissimus dorsi, its lower and upper portions. 2 Upper part of sacro-lumbalis. 4 Spinalis dorsi. 5 Cervicalis descendens. 6 Transversalis cervicis. 7 Trachelo mastoideus. 8 Complexus. 9 Transversalis cervicis, its insertion. 10 Semi-spinalis dorsi. 11 Semi-spinalis colli. 12 Rectus capitis-posticus-minor. 13 Rectus capitis-posticus major. 14 Obliquus capitis superior. 15 Obliquus capitis inferior. 16 Multifides spinæ. 17 17 Levatores costarum. 18 Inter-transversales. 19 Quadratus lumborum.

edges of the four or five superior ribs, by as many tendons, and forms a small fleshy belly, which is *inserted* by three or four tendons into the transverse processes of the fourth, fifth, and sixth cervical vertebræ. *Function.*—To draw the neck backward and to one side.

Transversalis colli (or *cervicis*) appears to be a continuation of the *longissimus dorsi*, and is about the same size with the last. It *arises* from the transverse processes of the four or six superior dorsal, and is *inserted* by small tendons into the transverse processes of the four or five lower cervical vertebræ. *Function.*—To draw the neck backward.

The *trachelo-mastoideus*, situated between the last and the complexus, seems also to be a continuation of the longissimus dorsi, upward. It *arises* tendinous from the transverse processes of the three or four superior dorsal, and four or five inferior cervical, and forms a very delicate and slender muscle, which ascends to be *inserted* into the posterior part of the mastoid process, beneath the splenius. *Function.*—To bend the head and neck backward and to rotate to one side.

The *complexus* is seen between the upper heads of the diverging splenii, and is a large and thick muscle. The tendinous matter noticed in its substance, gives it the complex appearance, whence its name is derived. It *arises* from the transverse and oblique processes of the five or seven superior dorsal, and three or four inferior cervical, and is *inserted* into the occipital bone, along with its fellow, on either side of the median line, between the two semicircular ridges. *Function.*—To draw the head back.

Fifth layer, (Fig. 151.)—*Dissection.*—Remove the muscles of the fourth layer, by dividing them in their middle and reflecting them to either end. This layer consists of the following five muscles:

The *rectus capitis posticus major*, is of a triangular shape, *arises*, tendinous and fleshy, from the spinous process of the vertebra dentata, and is *inserted* broad into the inferior transverse ridge of the os-occipitis. *Function.*—To draw the head back and rotate it on the atlas.

The *rectus capitis posticus minor*, like the last, is also

triangular, having its apex below and base above, being situated to the inner side of the rectus major, and with it occupying the space between the head and the first and second vertebræ. It *arises* from the tubercle on the posterior part of the atlas, and passes upward and outward to be *inserted* broad into the rough surface between the inferior transverse ridge, and foramen magnum of the occipital bone. *Function.*—To draw the head backward.

The *obliquus capitis superior* arises narrow from the transverse process of the atlas, and is *inserted,* by a broad attachment to the occipital bone, behind its mastoid process. *Function.*—To bend the head to one side and draw it backward.

The *obliquus capitis inferior* arises from the spinous process of the vertebra dentata, passes upward and outward, and is *inserted* into the extremity of the transverse process of the atlas. *Function.*—To rotate the atlas and head upon the dentata or second vertebra.

These four little muscles form nearly an equi-lateral triangle. The base consists of the recti along the middle line. The apex is the extremity of the transverse process, and the sides of the triangle are the superior and inferior oblique muscles. A quantity of fatty and cellular structure fills up this triangle, and deep in it are seen the vertebral artery, a plexus of veins, and the sub-occipital nerve.

The *semi-spinalis colli et dorsi* appears as one continued muscle, though it has been distinguished into two. They extend from transverse to spinous processes, encircling about one-half the vertebral column—hence their name. They are with difficulty distinguished from the multifidus spinæ.

The *semi-spinales colli* arise from the transverse processes of the five superior dorsal vertebræ, and are *inserted* into the spinous processes of the middle cervical vertebræ.

The *semi-spinales dorsi* arise from the transverse processes of the six lower dorsal vertebræ, and are *inserted* into the spinous processes of the two lower cervical, and four upper dorsal. *Function.*—To draw the spine obliquely backward.

Sixth layer, (Fig 151.)—*Dissection.*—Remove the semi-spinales. This layer consists of the deeper and more delicate muscles of the back and ribs.

The *inter-spinales*, as their name implies, are situated between the spinous processes of contiguous vertebræ. They consist of a succession of small, short muscles, which, in the neck, are in pairs, owing to the bifid state of the cervical spines. In the back they are quite indistinct, and in the loins they are mostly ligamentous, having a few muscular fibres intermixed. *Function.*—To extend the spine and keep it erect.

The *intertransversales* are also short muscles, and as their name indicates, are situated between the transverse processes. They are double and distinct in the neck, very indistinct in the back, and feeble in the loins.

Function.—To bend the spine laterally.

The *multifidus spinæ* consist of a multitude of small, fleshy and tendinous fasciculi, which are parallel to each other, and extend from transverse to spinous processes, the whole length of the spine. They *arise* each from the transverse or oblique process of one vertebra, and are *inserted* into the spinous process of the vertebra above, the fasciculi sometimes extending to the second or third vertebra above.

At the lower part of the spine the multifidus spinæ have also an attachment, tendinous and fleshy, to the back part of the sacrum, and the posterior part of the ilium. *Function.*—To support the spine and bend it to one side.

The *levatores costarum* are twelve in number, on each side of the chest, and are parallel to the external intercostal muscles. Each *arises* from the transverse processes of the dorsal and the last cervical vertebra, and is *inserted* into the ribs below, between the tubercle and angle. *Function.*—To elevate the ribs and assist in inspiration.

The *supra-spinales* are little fleshy fasciculi, or bands, described as being situated exclusively upon the spinous processes of the cervical vertebræ.

It will be seen from the above description of the muscles

of the back, that no very great regularity belongs to their several attachments, a fact which explains the apparent discrepancy among different authors.

SECTION III.

ORGANS OF DEGLUTITION—ŒSOPHAGUS.

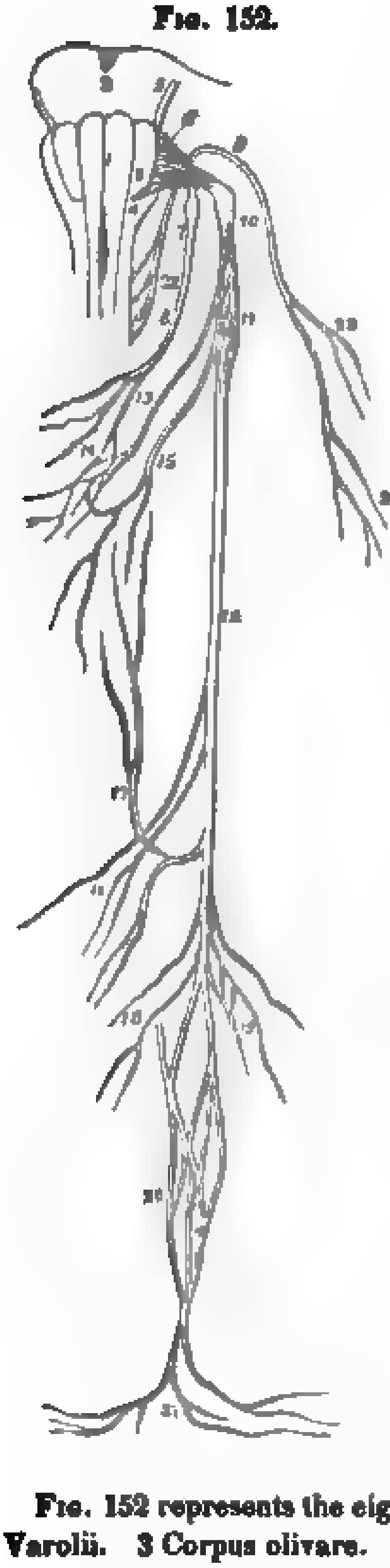
The œsophagus, (οἰειν, to bear, φαγος, food,) or food duct, is a continuation of the pharynx, and, as its name implies, is designed to convey our food and drinks from the mouth and pharynx downward into the stomach.

It *commences* at the lower portion of the pharynx, opposite the fifth cervical vertebra, and behind the cricoid cartilage, at its lower border. It then descends the neck nearly on the median line, lying first a little to the left of this line in the neck, then inclining, as it enters the chest, to the right; then again to the left, before it enters the stomach. This flexuosity explains the occasional difficulty of introducing the probang. It passes behind the trachea, the arch of the aorta, the pericardium, along the posterior mediastinum, and in front of the thoracic aorta, to the diaphragm, and terminates at the cardiac orifice of the stomach, opposite the tenth dorsal vertebra. It is made up of three distinct coats, with the blood-vessels and nerves. The coats are the external, the middle, and the internal, or muscular, cellular, and mucous.

The *muscular coat* is composed of two very distinct planes of fibres—the external, running longitudinally, and the internal, circularly, both being prolonged upon the stomach. The *cellular coat* forms the connecting medium between the muscular and mucous coats, and conducts the blood-vessels and nerves to the latter. The *mucous coat* is pale, thin, disposed in longitudinal folds, and covered by a delicate epithelium or cuticle. It also contains mucous follicles, sometimes called œsophageal glands, whose orifices are seen in the depressions between the longitudinal folds.

The *arteries* of the œsophagus come from the inferior thyroid in the neck; from the bronchial and aorta in the chest; and from the diaphragmatic and coronary artery of

Fig. 152.



the stomach. Its veins enter the inferior thyroid, the bronchial, vena azygos, superior vena cava, internal mammary, and coronary vein of the stomach. It has also *lymphatics* discharging their contents into the ganglia which surround it.

The *nerves* of the œsophagus are numerous and consist chiefly of branches from the pneumo-gastric, which surround it and constitute the œsophageal plexus.

The *pneumo-gastric*, (Fig. 152,) or par vagum, being so largely connected with the œsophagus, as well as with a variety of other important organs, demands a description in this place. This nerve, (classed along with the eighth pair, though a more strict classification makes it the tenth,) arises by numerous filaments, generally ten or twelve, from the medulla oblongata in the fissure between the corpora olivare and restiforme. These unite into one nerve, which joins the glosso-pharyngeal above, and the spinal accessory below, and the whole proceed to the foramen lacerum posterius, through

Fig. 152 represents the eighth pair of nerves. 1 Corpus pyramidale. 2 Pons Varolii. 3 Corpus olivare. 4 Corpus restiforme. 5 Facial nerve. 6 Origin of glosso-pharyngeal. 7 Ganglionum petrosum. 8 Trunk of glosso-pharyngeal. 9 Spinal accessory. 10 Ganglion of par-vagum or pneumogastric nerve. 11 Its ganglion taking the plexiform arrangement. 12 Trunk of par vagum. 13 Its pharyngeal branch. 14 Pharyngeal plexus. 15 Superior laryngeal nerve. 16 Cardiac branches. 17 Recurrent branch. 18 Anterior pulmonary branches. 19 Posterior pulmonary branches. 20 Œsophageal plexus. 21 Gastric branches. 22 Point where spinal accessory arises. 23 Sterno-mastoid branches. 24 Branches to the trapezius.

which they pass, and go to their several destinations. In the foramen lacerum, the par vagum is separated from the other nerves by dense cellular membrane, and from the jugular vein, which is behind, by a spicula of bone. At this point it also presents a swelling called the superior ganglion, and below this another enlargement called the inferior ganglion, about an inch in length. From these, filaments communicate with the facial, spinal accessory, glosso-pharyngeal, sympathetic, and superior spinal nerves, constituting a plexus termed the *basilar plexus*. From the inferior ganglion, which is of reddish color, the par vagum descends the forepart of the neck, along with the carotid artery and jugular vein, behind and between those vessels, and enclosed in the same sheath with them. At the root of the neck, the right par vagum enters the chest between the subclavian vein and artery, crossing the latter at right angles; on the left, this nerve runs parallel to the subclavian artery, crossing the arch of the aorta. Both nerves now proceed through the thorax to the posterior part of the root of the lungs, in the posterior mediastinum, and descend along the œsophagus, through the diaphragm, to terminate upon the stomach.

The par vagum in its course gives off the following branches:

The *auricular* commences at the superior ganglion, connects with the glosso-pharyngeal, enters a small canal of the petrous bone, upon the inside of the styloid process, then proceeds to join the facial in the aqueduct of Fallopius, and finally escapes in front of the mastoid process to supply the ear and its integuments.

The *pharyngeal* comes from the inferior ganglion at the base of the cranium, receives a branch from the spinal accessory, and descends behind the carotid artery to the side of the pharynx, at the upper margin of its middle constrictor. Here it anastomoses with branches from the glosso-pharyngeal, the superior laryngeal, and the sympathetic, forming the *pharyngeal plexus*, which supplies the mucous and muscular structures of the pharynx.

The *superior laryngeal* also arises from the inferior ganglion, and taking an arched course downward behind the internal carotid artery, enters the thyro-hyoid membrane along with the superior laryngeal artery, and principally supplies the mucous membrane of the larynx. This nerve is regarded as one of sensation.

The *cardiac nerves* have their origin from the vagus at the root of the neck, by two or three branches, which cross the carotid artery and join the sympathetic in the cardiac plexus.

The *inferior laryngeal* (or recurrent nerve) comes from the par vagum upon the right side, as it crosses the subclàvian artery. It curves around and behind this artery, and ascends to the larynx along the side of the trachea, covered by the inferior thyroid and common carotid arteries; at its origin it gives off filaments to the cardiac plexus, trachea, œsophagus, and thyroid gland, and finally terminates by supplying all the muscles of the larynx except the crico-thyroid. Branches have also been traced into the mucous membrane of the larynx.

The *recurrent* of the left side differs from that of the right, in curving round the arch of the aorta and ductus arteriosus. The recurrent, or inferior laryngeal nerves are essentially motor.

Pulmonary branches.—These come from the vagus, near the root of the lungs, and form a plexus, in front and behind the root, called the *anterior* and *posterior pulmonary plexuses.* The posterior is the larger, and both anastomose with the sympathetic and phrenic nerves, and accompany the pulmonary vessels and bronchial tubes, to supply the lungs.

Œsophageal branches.—These come from the pneumogastric above and below the root of the lung; but it is below the root that the nerves, on either side, come together, and, surrounding the œsophagus, constitute the *œsophageal plexus.* The left vagus goes in front, while the right passes behind the œsophagus.

Gastric branches.—These are the terminating branches of the pneumogastric upon the stomach. They form, around

the cardiac orifice of the stomach, the *cardiac plexus*. The right vagus goes to the posterior surface of the stomach, communicating with the solar, renal, splenic, and hepatic plexuses; while the left is distributed on the anterior surface, and lesser curvature of the stomach, sending some branches, by the lesser omentum, to the liver and gall-bladder.

It is evident, then, that the pneumogastric is a compound nerve, that is, that it combines filaments of sensation and motion—that it connects together a great variety of organs, as the pharynx, œsophagus, larynx, trachea, lungs, heart, and stomach, and influences an equally great variety of functions, as deglutition, voice, respiration, circulation, and digestion.

The œsophagus, besides the pneumogastric nerves, is also supplied with branches from the thoracic ganglia of the sympathetic.

SECTION IV.

ORGANS OF CIRCULATION OF THE NECK.

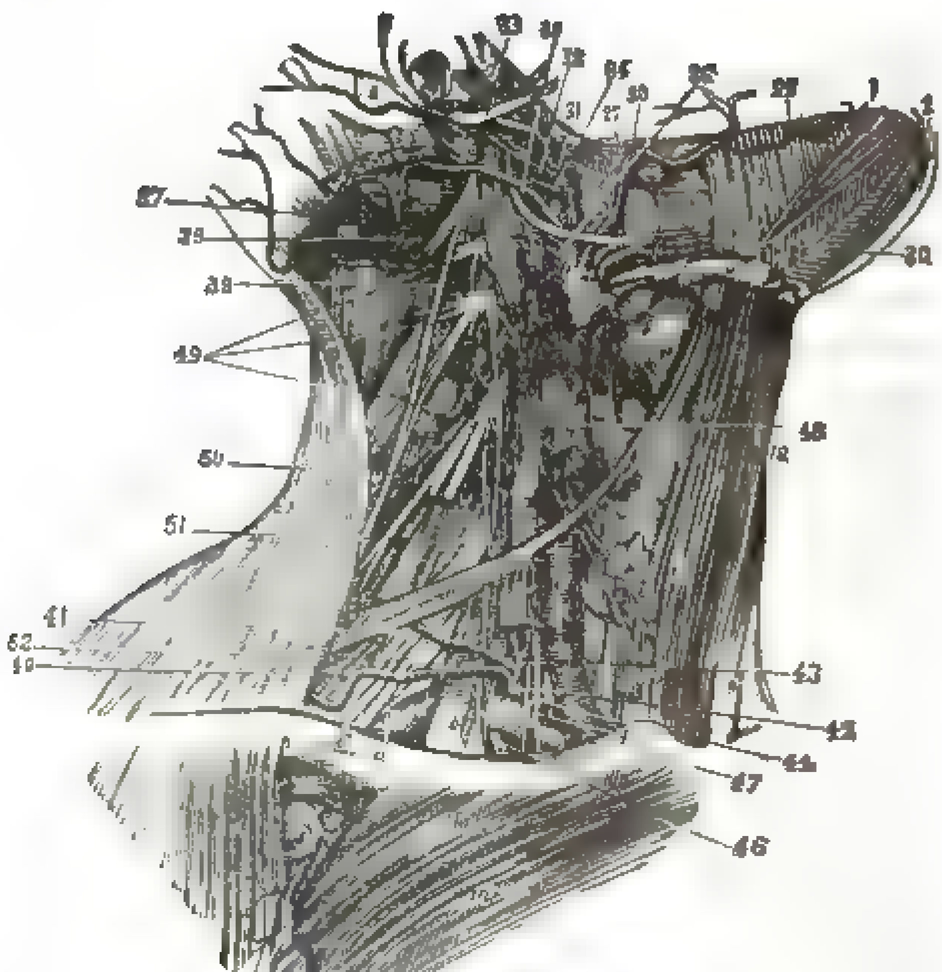
The organs of circulation in the neck comprise its blood-vessels, and consist of the *arteries* and *veins*.

The arteries supplying the upper part of the neck are, the *superior thyroid*, *facial*, and *occipital*—branches of the *external carotid*. The *vertebral*, the *thyroid axis*, and the *cervicalis posterior*, supply the lower part of the neck, and come from the *subclavian*.

The *external carotid* has been stated elsewhere, to arise from the common carotid, and this latter to arise from the arteria innominata, upon the right side, opposite the sterno-clavicular articulation, and upon the left, from the arch of the aorta. Both common carotids now ascend the neck nearly in a vertical direction, having in front, at their origin, the sterno-thyroid, the sterno-hyoid, and sterno-mastoid muscles; the descendens noni nerve along the middle front, and outside the sheath of the vessels, while the omo-hyoideus crosses in front about their middle. On the inside are

seen the larynx, the trachea, œsophagus, and thyroid gland; on the outside, the internal jugular vein in the same sheath with the artery; behind, these vessels rest upon the transverse processes of the cervical vertebra, the longus colli, and rectus capitis anticus major muscles, the

Fig. 153.



inferior thyroid arteries, and the inferior laryngeal and sympathetic nerves. The common carotids are also covered in front by the common integuments, platysma myoides, and superficial fascia of the neck.

Fig. 153 represents the Anterior Neck, showing its Blood-vessel, &c. &c. 1 Anterior bellies of the digastric muscle. 2 3 Mylo-hyoideus. 4 Hyo-glossus. 5 Stylo-glossus. 6 Styloid process. 7 Bifurcation of external carotid into internal maxillary and temporal. 8 Posterior auricular branch of the facial nerve and artery. 9 Stylo-pharyngeus, and middle constrictor of the pharynx. 11 Mastoid branch of external carotid. 12 Superior thyroid artery. 13 Thyro-hyoid membrane. 14 Thyro hyoid muscle. 15 15 Sterno-thyroid. 16 Thyroid gland. 17 17 Omo-hyoid muscle. 18 18 Sterno hyoid. 19 Sterno-mastoid. 20 Upper attachment of the sterno-mastoid. 22 Obliquus capitis-superior. 23 Complexus muscle. 24 Splenius capitis. 25 Levator anguli scapulæ. 26 Scalenus posticus. *a* Scalenus medius. *b* Scalenus an-

Each common carotid terminates opposite the upper border of the thyroid cartilage, by dividing into the external and internal carotids.

From this point, the *external carotid* ascends to the neck of the lower jaw, where it ends in the temporal and internal maxillary arteries. In this course it is crossed, near its origin, by the lingual nerve, then by the stylo-hyoid and digastric muscles; and, still higher, it is imbedded in the parotid gland, and crossed by the facial nerve. The platysma, superficial fascia, and skin form the superficial covering in front, while behind, it is separated from the internal carotid, by the stylo-glossus and stylo-pharyngeus muscles, and the glosso-pharyngeal nerve.

The external carotid gives off ten branches, which have been already detailed in describing those of the head. We shall, therefore, only recapitulate here those belonging to the neck.

The *superior thyroid*, arising from the anterior part of the external carotid, near its origin, descends beneath the omo-hyoid and sterno-thyroid muscles, to the thyroid gland. In its course it gives off the following branches:

Superficial branches to the integuments and superficial muscles; *hyoid*, to the lower border of the hyoid bone and its muscles; *superior laryngeal*, which goes along with the superior laryngeal nerve, through the thyro-hyoid membrane, and is distributed to the mucous membrane and muscles of the larynx; *inferior laryngeal*, supplying the

ticus. *c* Common carotid artery. *d d* Subclavian. *e* Brachial plexus. *f g* Internal jugular vein. *h* Inferior constrictor. *i* Œsophagus. *j* Trapezius. *k* Deltoid. *l* Pectoralis major—its clavicular portion. *m* Its sternal portion. *n* Subclavius muscle. *o* Axillary artery. 27 Facial artery. 28 Its submental branch. 29 Hypoglossal nerve. 30 Lingual artery. 31 External carotid. 32 Posterior auricular artery. 33 Facial nerve. 34 Glosso-pharyngeal nerve. 35 Occipital artery. 36 Superior laryngeal nerve. 37 Descendens noni nerve. 38 Spinal accessory nerve. 39 Princeps cervicis artery. 40 suprascapular artery. 41 Transversalis colli. 42 Thyroid axis. 43 Inferior thyroid artery. 44 Vertebral artery. 45 Par vagum nerve. 46 Internal mammary artery. 47 Phrenic nerve. 48 Communicating nerve. 49 Second, third. and fourth cervical nerves. 50 Cervical plexus. 51 Cervicalis ascendens artery. 52 Brachial plexus.

crico-thyroid membrane, and entering into the interior of the thyroid gland, and anastomosing freely with the inferior thyroid.

The *facial artery*, called also the *labial*, or *external maxillary*, arises also from the front of the external carotid, opposite the os-hyoides, and ascends to the lower jaw behind, and in the substance of the submaxillary gland. Thence it proceeds to the angle of the mouth, and thence by the side of the nose, to the angle of the eye, where it terminates by anastomosing with the ophthalmic. Its branches supplying any portion of the neck, are chiefly the *glandular*, distributed to the submaxillary and lymphatic glands, and the *submental*, which leaves the facial just as it is mounting over the lower jaw, and proceeds forward, covered by this bone, passing over the anterior belly of the digastricus, and beneath the origin of the mylo-hyoideus to the chin, which, with the adjacent muscles, it supplies, and ends by anastomosing with the inferior dental and sublingual branches.

The *occipital* arises opposite the facial, from the posterior part of the external carotid, and ascends backward behind the posterior belly of the digastric, the sterno-mastoid, and trachelo-mastoid muscles, to the groove at the root of the mastoid portion of the temporal bone. It now proceeds horizontally backward, between the splenius and complexus muscles, to the mesial line of the atlas, and thence ascends upon the occiput, terminating in numerous branches which anastomose with its fellow, the posterior auricular, and the temporal arteries. Its cervical branches supply the superficial and deep muscles on the posterior and superior part of the neck. The *arteria princeps cervicis* is the name applied to the deep branch which descends to the complexus and semi-spinalis muscles, and anastomoses with the *profunda cervicis* of the subclavian, thus forming the collateral circulation between the branches of the external carotid and subclavian arteries.

The *subclavian artery*, (Figs. 120, 153,) on the right side, arises from the *arteria innominata*, opposite the sterno-cla-

vicular articulation; thence it proceeds obliquely outward to the inner margin of the scalenus anticus muscle, constituting its first stage. It now passes between the scalenus anticus and scalenus medius, forming its second stage. After emerging from these muscles it proceeds downward and outward, beneath the clavicle, to the lower margin of the first rib, forming its third stage, where it terminates as subclavian, and becomes axillary.

The right subclavian has anterior to it, in its first stage, the internal jugular and subclavian veins, the pneumogastric, phrenic, and cardiac nerves; the sterno-mastoid, sterno-hyoid and sterno-thyroid muscles. Behind are the inferior laryngeal and sympathetic nerves, the vertebral vein, and some cellular tissue and lymphatic glands. In its second stage it lies between the scaleni muscles, separated by the scalenus anticus from the subclavian vein and phrenic nerve, and accompanied by the brachial plexus of nerves. In the third stage the subclavian vein, the subclavian muscle, and the clavicle are in front; the brachial plexus and the omo-hyoid are above and external, and behind are the scalenus posticus and the first rib, while the skin, platysma, and fascia form the superficial covering.

The *left subclavian* differs from the right in having its origin from the arch of the aorta; in being longer; in pursuing nearly a vertical course to the scaleni muscles; in having the pneumogastric running parallel with instead of crossing it; in not having the recurrent passing around it; in having the vena innominata, left carotid, left lung, and pleura in front; and in having the thoracic duct and longus colli muscle behind. In the second and third stages the relations of the subclavian are nearly the same on both sides.

BRANCHES OF THE SUBCLAVIAN SUPPLYING THE NECK.

The *vertebral* artery is the largest branch, and comes off from the subclavian at its upper and posterior part. It then ascends upon the vertebral column behind the inferior thyroid artery, and after a short course enters the foramen in

the transverse process of the fifth or sixth, and sometimes of the seventh cervical vertebra. It passes upward in the bony canal formed by the several foramina placed one above another in the corresponding transverse processes, as high as the *dentata* or second vertebra. Here it bends outward and backward to the foramen in the transverse process of the atlas, and then makes a very remarkable curve inward and backward, round the articulation of the atlas, entering the foramen magnum through the dura mater. It ascends upon the medulla oblongata, and at the lower margin of the pons, it unites with its fellow to form the basilar artery.

In the canal the vertebral artery sends out anterior, posterior, and external branches, supplying the intertransversales, complexus, splenius, rectus capitis anticus major, and scaleni muscles; while its internal branches go into the spinal canal and supply the dura mater, and spinal marrow. In its transverse bend, between the atlas and occiput, it distributes a number of branches to the posterior recti and oblique muscles of the head. It supplies also the spinal nerves, and at the foramen magnum gives off the anterior and posterior spinal arteries that descend the cord its whole length. The remaining branches of the vertebral and basilar arteries, are given in the account of the brain.

The *thyroid axis* arises from the subclavian at its upper part and near the inner edge of the scalenus anticus. It is a short, thick trunk, and gives off four principal branches:

The *inferior thyroid*, the *superior scapular* or *transversalis humeri*, the *posterior scapular* or *transversalis colli*, and the *cervicalis anterior* or *ascending cervical*.

The *inferior thyroid* ascends behind the common carotid to the thyroid gland, where it anastomoses with the superior thyroid, supplying in its course the trachea, œsophagus, and lower part of the larynx.

The *superior scapular* proceeds behind the clavicle obliquely outward to the supra scapular-notch, over whose ligament it passes to supply the supra-spinatus, and then goes beneath the acromion to the infra-spinatus and teres

minor. In its course it crosses the scalenus anticus, the phrenic nerve, and the brachial plexus. This vessel not unfrequently comes from the subclavian.

The *transversalis colli*, or posterior scapular passes transversely outward over the scaleni muscles, and through the brachial plexus to the superior posterior angle of the scapula, where it ends in two branches, the *superficial cervical*, supplying the trapezius, splenius, and levator scapulæ; and the continued trunk, the *posterior scapular*, which descends along the base of the scapula to supply the rhomboid and other muscles arising from this quarter. It anastomoses with the subscapular, a branch of the axillary.

The *cervicalis anterior* or ascending cervical ascends upon the scalenus anticus, supplying it, the longus colli and the rectus capitis anticus major, and sending branches to the spinal cord and its membranes.

The *profunda cervicis*, or cervicalis posterior, arises from the upper and back part of the subclavian, on a level with and outside of the vertebral; it ascends outward and backward between the transverse processes of the sixth and seventh cervical vertebræ, ascending on the back of the neck to supply the complexus and other deep muscles, and anastomosing with the descending branches of the occipital. This vessel is sometimes a branch of the superior intercostal.

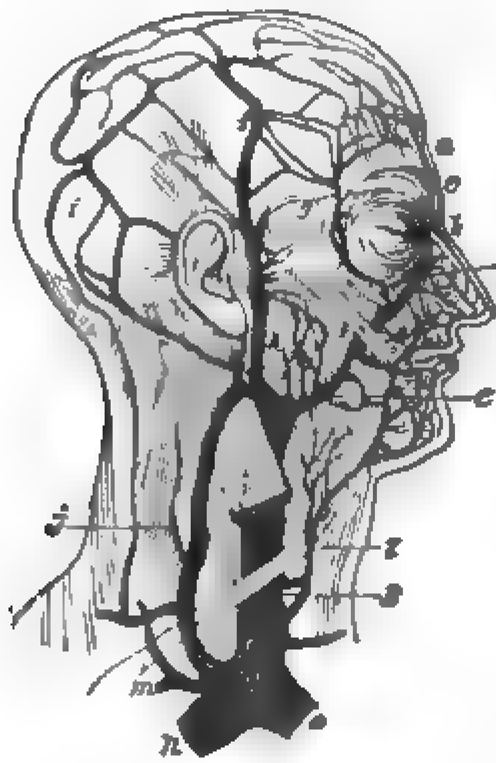
VEINS OF THE NECK, (Fig. 154.)

The veins of the neck belong to the external jugular, internal jugular, anterior jugular, and subclavian veins.

The *external jugular* begins at the angle of the lower jaw by the junction of the internal maxillary and temporal veins; it then descends the neck, crossing the sterno-mastoideus, covered by the platysma myoides and superficial cervical fascia. At the root of the neck it penetrates the deep cervical fascia behind the attachment of the sterno-mastoideus, and terminates in the subclavian on the outside of the internal jugular. Its upper portion is accompanied by the auricularis magnus nerve, one of the ascending filaments of the cervical plexus. The branches which

enter into the external jugular, besides the temporal and internal maxillary, are the occipital, posterior cervical cutaneous, and the posterior and supra scapular veins, the last of which joins it at its termination. This vein communicates with the internal jugular, generally at its upper part, and in its descent with the anterior jugular. It is, however, very variable, being sometimes double and very small. It returns the blood from the external parts of the head, integuments and superficial muscles of the neck.

Fig. 154.



The *internal jugular vein* is the great channel receiving the blood of the sinuses already noticed in the account of the brain. It commences at the foramen lacerum posterius, where the lateral sinuses terminate, then descends the neck first on the outside of and a little behind the internal carotid, then on the outside of the common carotid artery to the root of the neck, where it joins with the subclavian to form the *vena innominata* of each side—at its superior portion the ninth and eighth pair of nerves are on its inside, and the styloid process with its muscles are in front. The lingual and glosso-pharyngeal nerves are between this vein and the artery a little lower down, while the spinal accessory passes behind in its outward direction. The rest of the course of this vein is enclosed in the same sheath with the common carotid artery and pneumogastric nerve, receiving in its descent the facial, lingual, pharyngeal, and thyroid veins, and communicating freely with the external jugular.

Fig. 154 represents the Veins of the Neck and Head. *a* Frontal vein. *b* Nasal vein. *c* Supra orbital. *d* Angular vein. *e* Facial vein. *f* Superficial temporal veins. *g* Middle temporal. *h* Masseteric plexus of veins. *i* Occipital veins. *j* External jugular. *k* Internal jugular. *l* Anterior jugular *m* Scapular veins. *n* Subclavian vein. *o* Vena innominata.

The *anterior jugular*, called also *superficial thyroid vein*, begins at the os-hyoides, and descends along the anterior margin of the sterno-mastoideus, near the median line of the neck, covered by the superficial cervical fascia, and terminates below, either in the external jugular or subclavian veins. The two anterior jugulars often connect by a transverse branch and frequently communicate above with the facial, internal, and external jugular veins. They also vary much in size and return the blood from the superficial parts on the front of the neck.

The *subclavian veins* are continuations of the axillary, and are situated beneath the clavicle and subclavius muscle. Passing over the first rib, in front of the subclavian artery, and crossing the scalenus anticus muscle, they terminate by uniting with the internal jugular, to form the right and left vena innominata, which also unite to constitute the superior vena cava. The subclavian veins receive the tributary streams of the *external jugular veins*, the *vertebral*, *inferior thyroid*, *inferior laryngeal*, *internal mammary*, and *superior intercostal*—though these latter frequently empty into the vena innominata.

SECTION V.

ORGANS OF INNERVATION, OR NERVES OF THE NECK.

These are the par vagum, spinal accessory, lingual, facial, cervical plexus and phrenic nerve, brachial plexus, sympathetic nerve and its ganglia.

The *par vagum* (Fig. 152) has been already fully described under the head of *organs of deglutition* in the neck, which see.

The *spinal accessory* nerve, (Fig. 153,) or third division of the eighth pair, called the superior respiratory nerve of Sir Charles Bell, arises as low down in the neck as the fourth or fifth cervical vertebra, by several filaments from the respiratory tract, between the anterior and posterior spinal roots; it ascends behind the ligamentum denticulatum, to the base of the cranium, passes through the foramen mag-

num, and joins the other divisions of the eighth pair, along with which, and enclosed in the same sheath, it passes through the foramen lacerum posticus, and thence to the muscles on the side of the neck.

In the foramen lacerum it is connected to the vagus by one or more filaments. On the outside of the foramen it divides itself into two branches—*internal* and *external*. The former is the smaller and joins the pneumogastric, while the external is the continuation of the accessory nerve, which proceeds outward, behind the internal jugular vein, to the sterno-mastoid muscle, the upper third of which it perforates and supplies with filaments, anastomosing with the second, third, and fourth cervical nerves, and finally being distributed upon the trapezius as low down as the scapula.

The function of this nerve is regarded as purely motor, though the observations of Todd and Bowman assign sensation to the fibres of the internal branch. This nerve, along with the pneumogastric, has been compared to a compound or spinal nerve, the spinal accessory being the motor, while the vagus, with its ganglia, represents the sensory.

The lingual, hypoglossal, or ninth pair of nerves, (Fig. 91.) This nerve is the motor nerve to the tongue, as well as to several structures at the superior part of the neck. It arises from the medulla oblongata between the corpus pyramidale and corpus olivare, by six or ten filaments, which, uniting together, pass out of the cranium through the anterior condyloid foramen of the occipital bone. It then proceeds forward, between the internal jugular vein, and internal carotid artery, ascending with the vein as low as the angle of the jaw, when it curves across the occipital branch of the external carotid, taking the course of the digastric muscle and lingual artery, to the base of the tongue above the os-hyoides; here it passes above the mylo-hyoides, crossing the hyo-glossus, and dividing into filaments which supply these muscles, the genio-hyo-glossus and the lingualis, and continued forward through the tongue as far as its tip.

The branches of this nerve are, first, those which communicate, on the outside of the condyloid foramen, with the pneumogastric, sympathetic, spinal accessory, and first and second cervical nerves. As it crosses the occipital artery it sends off the *descendens-noni*, which descends in front of and outside the sheath of the common carotid artery, to the middle of the neck, where it meets with branches from the second and third cervical nerves, forming a plexus which is distributed upon the sterno-hyoid, thyroid, and omo-hyoid muscles. About the os-hyoides, filaments of the lingual have been traced to the constrictors of the pharynx, stylo-pharyngeus, and thyro-hyoid muscles; and on the hyo-glossus, communicating branches form a plexus with the gustatory branch of the fifth pair.

The *facial nerve* is described under the organs of expression, to which the reader is referred.

The *cervical plexus* (Fig. 153) is divided into the *anterior* and *posterior* cervical plexuses. The former is formed by the union of the anterior branches of the four superior cervical nerves, and is situated upon the side of the neck, between the trapezius and sterno-mastoid muscles, corresponding to the second, third, and fourth vertebræ, and covered by the platysma and fascia. This plexus rests upon the origin of the splenius and levator anguli scapulæ muscles, and communicates with the eighth and ninth nerves, and the superior cervical ganglion of the sympathetic. Its branches are divided into *ascending* and *descending*, and these again into *superficial* and *deep*.

The *superficial* consist of—Superficialis colli, Auricularis magnus, and Occipital.

The *superficialis colli* comes from the second and third cervical nerves, winds round the mastoid muscle, and ascends, along with the external jugular vein, to the angle of the jaw, supplying filaments to the lower part of the face, and to the integuments of the lateral and anterior regions of the neck, and connecting with the cervico-facial.

The *auricularis magnus* comes also from the second

and third cervical nerves, is larger than the last, and ascends behind the mastoid muscle, to the parotid gland, where it divides into a superficial branch, supplying the integument over the parotid gland and anterior ear, and a deep one which enters the lower part of the gland, passes over the mastoid process, and is distributed to the back of the ear, and side and back of the scalp, and communicating with the facial and occipital nerves.

The *occipitalis minor* arises from the second cervical, and proceeds upward, behind the mastoid muscle, to supply the skin of the back part of the head, and the occipital part of the occipito-frontalis muscle.

The *descending branches* of the cervical plexus are divided into superficial and deep. The former consist of external, middle, and internal branches, which, supply the integuments upon the sides of the neck, and extend down upon the pectoral and deltoid muscles.

The *deep descending* branches consist of the *muscular*, the *communicating*, and the *phrenic.*

The *muscular* supply the trapezius, levator anguli scapulæ, and sterno-mastoid muscles, and come from different parts of the plexus.

The *communicating* connect with the sympathetic, pneumo-gastric, and lingual nerves near the base of the cranium, and in front of the atlas.

A nerve called the *communicans noni*, is a long, delicate branch, coming from the second and third cervical nerves, which descends generally in front of the sheath of the cervical vessels, though sometimes on the outside of the internal jugular vein, and occasionally behind it, to the middle tendon of the omo-hyoid, where it unites in the form of a loop, with the descendens noni.

The *phrenic* is a very important nerve, and is the *internal respiratory* of Sir Charles Bell. It arises from the third and fourth cervical nerves, with additional filaments from the fifth and sixth, and sometimes from the seventh, connecting with the sympathetic. It descends in front of the scalenus anticus muscle, and at the root of the neck com-

municates with the inferior cervical ganglion, and frequently with the vagus and its recurrent branch; at this point it enters the chest between the subclavian artery and vein, and proceeds downward on the side of the pericardium in the middle mediastinum, to the diaphragm, to which it is distributed, sending branches on the right side to the liver and vena cava, and on the left to the œsophagus and stomach. The left phrenic is longer than the right from the direction of the heart to the left side. It has been commonly considered to be a purely motor nerve, but Laschka's recent researches show that it contains sensory filaments also. He states that it effects a double interchange between the spinal and the sympathetic nerves. It commonly arises only from the fourth cervical nerve. The diaphragmatic branches go to the tendinous centre, the inferior cava, the right auricle, and the liver.

The *posterior cervical plexus* is formed by the junction of the posterior branches of the first, second and third cervical nerves. It is situated beneath the complexus. Its branches are called musculo-cutaneous and occipitalis major.

The *musculo cutaneous* supplies the complexus and semispinalis colli, and then passes through the trapezius to become cutaneous, being distributed to the integuments on the back of the neck and head.

The *occipitalis major* comes from the second cervical nerve, takes the course of the occipital artery, and supplies the muscles on the back part of the neck and head. The posterior branches of the lower cervical nerves supply the muscles and integuments on the lower and back part of the neck and head.

The *brachial plexus* (Fig. 153) is situated at the lower part of the neck in the posterior, inferior, lateral triangle, above the clavicle, and between the mastoid and posterior belly of the digastric muscles. It is formed by the union of the four inferior cervical and first dorsal nerves: the fifth and sixth unite into one trunk; the eighth cervical and first dorsal also unite into one trunk; the seventh cervical stands alone for some distance, so that this plexus presents

at first three roots, which again divide and unite in a variety of ways to constitute this plexus. Its lower part receives the name of axillary plexus. This plexus communicates with the cervical by means of a filament from the fourth cervical nerve. In the neck it passes between the scalenus anticus and medius muscles, above and outside of the subclavian artery, under the clavicle and sub-clavian muscle, over the first rib to the axilla, where the branches of this plexus so interlace as completely to surround the axillary artery from the clavicle to the head of the humerus.

The brachial plexus is very extensive, and sends branches to the neck, the anterior part of the chest, and the upper extremity. Only those going to the neck claim our attention in this place. The balance of this plexus will be considered in its appropriate relations with the organs of the chest and superior extremity.

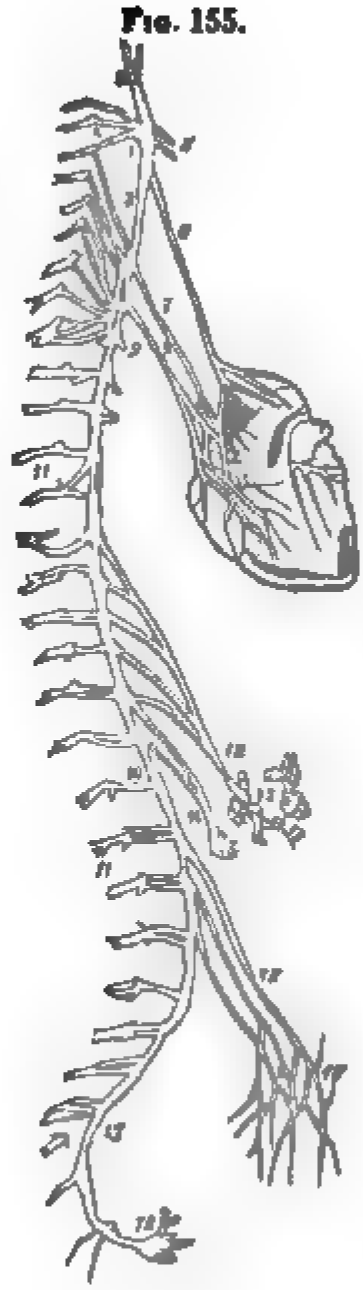
The branches supplying the neck are termed *supra clavicular*, and go to the subclavian muscle, the scaleni, levator anguli scapulæ, and rhomboid muscles.

The *posterior thoracic*, called also the *external respiratory* nerve of Mr. Bell, arises from the fourth, fifth and sixth cervical nerves, passes downward and outward, behind the brachial plexus and vessels, upon the scalenus posticus, and ultimately terminates in the great serratus muscle. This is a very long nerve, and from its origin so near the phrenic, its function, according to Bell, is to associate the serratus magnus muscle with the diaphragm in respiration.

Sympathetic nerve of the neck.—The sympathetic nerve is so called from its extensive relation with all the various parts of the body, connecting the several organs and viscera, and uniting the whole in one harmonious action or series of actions. It is also styled *ganglionic*, from the number of ganglia which occur upon it. By Bichat it was named the nervous system of *organic* life—in contradistinction to the cerebro-spinal or nervous system of *animal life*. Other terms, as the *intercostal*, splanchnic,

and automatic, have all been applied to it.

Fig. 155.



The sympathetic is not a single nerve, but consists of two cords extending from the base of the cranium to the coccyx. Each of these cords descends along the neck anterior to the vertebræ, behind the carotid artery and jugular vein, and in front of the rectus-capitis and longus colli muscles. In the chest they are traced along the sides of the spine, over the heads of the several ribs, and are found entering the abdomen beneath the true ligamentum arcuatum. They descend on the anterior part of the lumbar vertebræ, between the psoas muscles and crura of the diaphragm, into the pelvis; they pass along the anterior surface of the sacrum to the first bone of the coccyx, where the two cords unite in a small ganglion, called *coccygeal* or *ganglion impar.*

Throughout the whole course of these nerves a series of knots or ganglia are observed, named according to their situation, cervical, dorsal, lumbar, and sacral; there being three cervical, twelve dorsal, five lumbar, and three sacral.

Fig. 155 represents the Sympathetic Nerve its entire length. 1 Superior cervical ganglion. 2 Its ascending branch. 3 Descending branch. 4 External branches connecting with the first, second and third cervical nerves. 5 Internal branches connecting with the eighth, ninth and facial nerves. 6 Superior cardiac nerve. 7 Middle cardiac nerve. 8 Inferior cardiac nerve, coming successively from the first, second and third cervical ganglia. 9 First dorsal ganglion. 10 Last dorsal ganglion. 11 Spinal nerves. 12 Great splanchnic nerve. 13 Semilunar glangia forming the solar plexus. 14 Lesser splanchnic nerve, going to the renal plexus. 15 Branches from the lumbar ganglia. 16 Hypogastric plexus. 17 Sacral ganglia. 18 Ganglion impar or last ganglion of the sympathetic.

From these ganglia an immense number of branches radiate in *every direction, constituting so many plexuses.* The plexuses follow the course of the several arteries, receiving the names of the respective vessels they pursue, as the hepatic, gastric, splenic, renal, &c. In many instances they form complete nervous sheaths around the vessels.

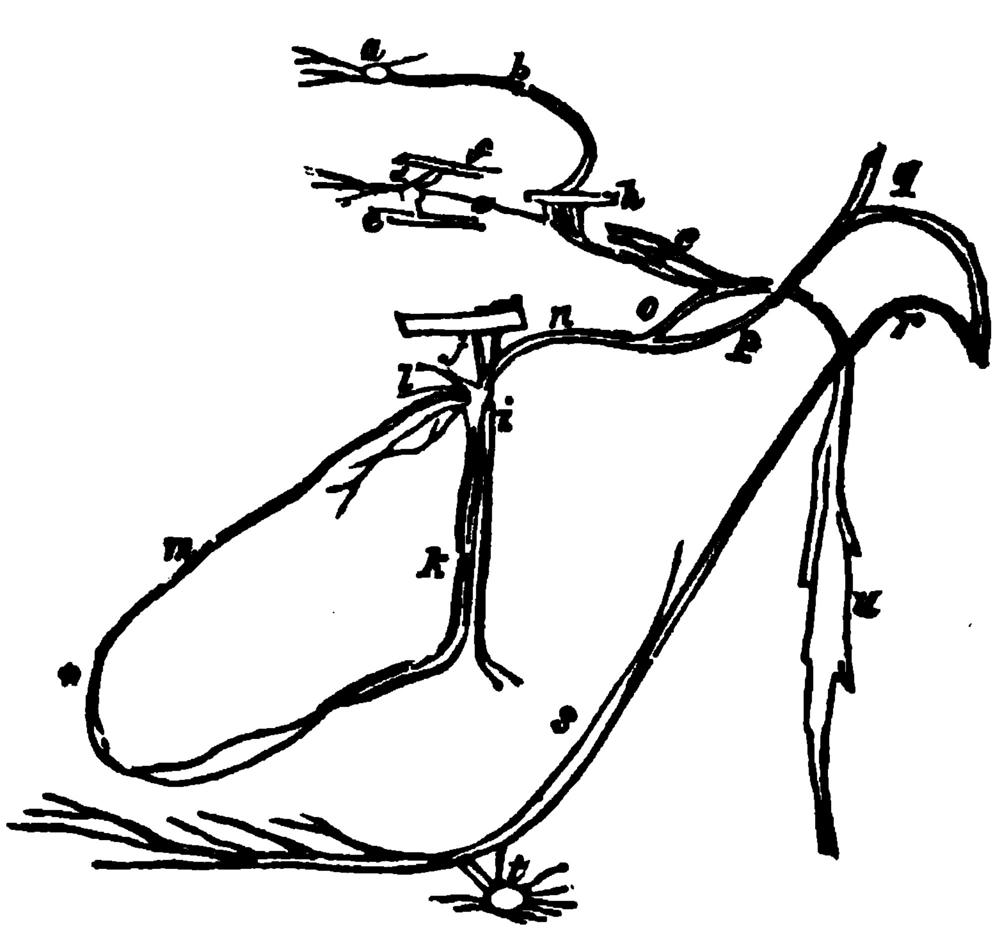
The sympathetic cords, it will be observed, in their descent along the spinal column, connect with all the spinal nerves by one or two filaments—with the cervical generally by one, and with the dorsal, lumbar, and sacral by two. At their superior extremity they also communicate with all the cerebral nerves as they emerge from the cranium, except the fourth and sixth pair, and with these they unite in the cavernous sinus; while with the olfactory, optic, and auditory, the union occurs in their ultimate expansion. There is also a communication of the sympathetic nerves with the several ganglia of the head, which ganglia are regarded as the same with the rest of the ganglionic system. And though they have been described along with the several organs of the head, yet for the purpose of having a connected view of the whole we introduce the following summary and figure (156.)

Six sympathetic ganglia are found belonging to the head, as follows:

The *ganglion* of *Ribes*, named after its discoverer, and situated upon the anterior communicating artery. This ganglion is the point of junction of the sympathetic cords of the opposite sides of the body, at their superior part. It sends filaments to the carotid plexus.

The *lenticular, ciliary* or *ophthalmic ganglion*, is situated within the orbit, on the outside, and in close contact with the optic nerve, and imbedded in a quantity of fatty matter. It is a small, flattened and grayish body, sending off the ciliary nerves to the eye, and, according to Tiedemann, a filament along with the arteria centralis retinæ. It communicates with the *nasal branch* of the ophthalmic, with the third or motor oculi, and with the carotid plexus

FIG. 156.



by a long filament going backward to the cavernous sinus.

The *spheno-palatine*, or *ganglion* of *Meckel*, is situated in the spheno-maxillary fossa, in a quantity of fat surrounded by branches of the internal maxillary artery, and presents a reddish triangular appearance. It gives off three sets of branches internal or nasal, descending or palatine, and posterior or Vidian—all of which have been described with the superior maxillary nerve, under the head of active organs of mastication. This ganglion of Meckel, by means of its Vidian nerve, which takes a most circuitous and lengthy route, as already described, establishes a communication with the carotid plexus, and through this latter with the superior cervical ganglion—with the glosso-pharyngeal and pneumogastric, by its tympanic branch, with the facial, superior, and inferior maxillary nerves, and with the submaxillary ganglion.

The sub-maxillary ganglion is in contact with the sub-

FIG. 156 represents the Cranial Ganglia of the Sympathetic Nerve. *a* Ganglion of Ribes. *b* Filament connecting with the carotid plexus *c*. *d* Lenticular ganglion *e* Third nerve getting a filament from the ganglion. *f* Nasal nerve also getting a filament from the ganglion. *g* A sympathetic filament going to carotid plexus. *h* Sixth nerve in cavernous sinus, getting two filaments from carotid plexus. *i* Spheno-palatine or Meckel's ganglion. *j* Branches connecting with superior maxillary nerve. *k* Palatine or descending branches. *l* Spheno palatine or nasal branches. *m* Naso palatine, a branch of the latter. *n* Vidian or pterygoid nerve. *o* Its carotid branch. *p* Petrosal branch. *q* Facial nerve. *r* Chorda-tympani. *s* Gustatory nerve. *t* Submaxillary ganglion. *u* Superior cervical ganglion of the sympathetic.

maxillary gland, is of small size, and communicates with the gustatory and lingual nerves, and with the sympathetic filaments of the facial artery, also, through the Vidian nerve, with the carotid plexus and the rest of the cranial ganglia.

The otic-ganglion (or ganglion of Arnold) is found, directly below the foramen ovale, on the inside of the inferior maxillary nerve, upon the outside of the Eustachian tube, and anterior to the middle meningeal artery. It is a small, not very distinct, and reddish body, distributing filaments to the tensor palati and tensor tympani muscles, and communicating, by its branches, with both the motor and sentient portions of the inferior maxillary, and with the facial and tympanic branches of the glosso-pharyngeal.

The naso-palatine or *ganglion of Cloquet.*—The existence of this body as a proper ganglion has been doubted. It is very small, and when present, found in the foramen incisivum, distributing branches to the anterior palate, and communicating with the ganglion of Meckel, by means of the internal nasal branch passing off from this latter ganglion and going to the ganglion of Cloquet.

Ganglion of Laumonier—(Fig. 157.)—This ganglion, named after its discoverer, is generally seen on the under surface of the carotid artery, within the carotid canal, though sometimes found in the cavernous sinus. It is small, and appears to be an expansion of the petrosal nerve before joining the carotid plexus, and is also called the *ganglion caroticum*, or *cavernosum*.

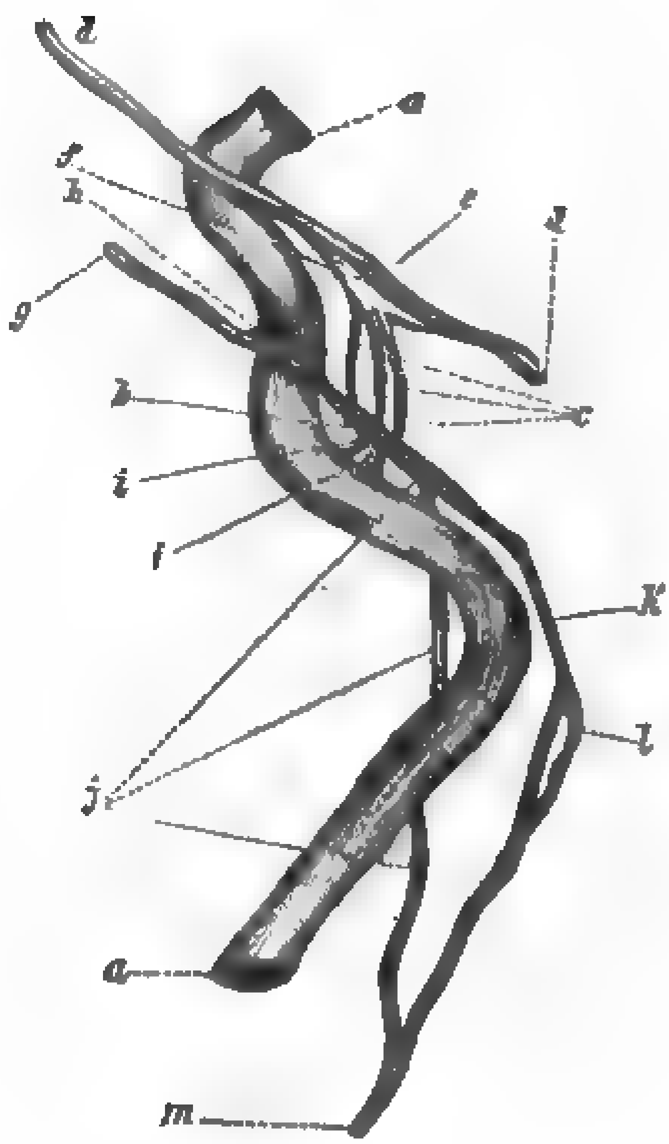
It is represented as a flattened, elongated ganglion, forming the connecting link between the cranial and extracranial portions of the sympathetic.

A variety of opinions are entertained as to the *origin* of the sympathetic. Some say it arises in the brain; others, along the course of the spinal marrow, and its coccygeal extremity; while others, more recently, place its origin in the lining coat of the arteries.

Those who assert its origin from the brain, say it is

by the union of the Vidian branch of the fifth and sixth pair of nerves, whose diverse properties coming together, constitute, as it were, a tertium quid, styled the sympathetic. This view is explained by the accompanying figure, from Lobstein.

[Fig. 157.



The latter opinion, which places the origin in the interior of the arteries, regards the lining coat of these vessels as essentially nervous, and makes the semilunar ganglion, in the abdomen, the great centre of this system. Whatever may be its origin, there is strong reason for believing, with Bichat, that it is the especial nerve or system of nerves for organic life, presiding over the functions of involuntary motion, as digestion, absorption, circulation, secretion—in a word, all the functions of nutrition. There are also

Fig. 157 represents the origin of the Sympathetic Nerve, agreeably to Lobstein. *a a* Carotid artery. *b* Ganglion of Laumonier. *c* From this latter ganglion three branches are sent off to join the sixth pair of nerves. *d* The sixth nerve separated into two fasciculi. *e* The superior fasciculus. *f* The inferior fasciculus parted, by a groove, from the superior; and it is the inferior which unites with the three branches from the ganglion. *g* Petrosal branch of Vidian nerve joining the ganglion. *h* Twig of the latter branch. *i i* Filaments proceeding from the ganglion to the artery. *j* A branch going behind the carotid from the ganglion. *k* A branch going from the ganglion in front of carotid, dividing it. *l m* Sympathetic nerve.]

reasons for believing it to be not only independent of the brain and spinal marrow, but the original and formative system to these latter portions as well as to the rest of the animal body.* Well authenticated cases are recorded of the absence of the brain, in *acephalous fœtuses;* and still further, of the whole cerebro-spinal system. But no cases, we believe, are recorded of the sympathetic system being wanting, which seems fairly to show independence, as well as priority of existence.

The *sympathetic*, in the neck, presents three ganglia, the *superior cervical*, *middle*, and *inferior cervical*, (Fig. 155.)

The superior cervical ganglion is *situated* upon the rectus capitis anticus, on the inside of the eighth and ninth pair of nerves, and behind the internal carotid artery and jugular vein. It is of an oval shape, and reddish color, extending from the first cervical vertebra, about half an inch below the carotid foramen, to the third.

Its branches are—*superior*, *inferior*, *internal*, *external*, and *anterior*. The *superior*, two in number, ascend in the carotid canal, where they form the carotid plexus. Here a junction with the Vidian branch of the fifth and the sixth occurs, and from this point filaments are traced into the cavernous sinus, constituting the cavernous plexus, and from thence to the Casserian ganglion—also to the lenticular ganglion, while others are found accompanying the ophthalmic artery and its branches.

The *inferior* branch forms the continued trunk of the sympathetic, which connects this with the middle or lower cervical ganglion.

The *internal* branches proceed to the pharynx, larynx, and heart. Those of the *pharynx* unite with the glossopharyngeal and par vagum, forming the pharyngeal plexus. The *laryngeal* unite with the branches of the superior laryngeal nerve, while the *cardiac* descend the neck, behind the sheath of the common carotid, entering the chest, along

* See appendix to Sir Wilson Philip on "*acute* and *chronic* diseases," by James H. Miller, M. D., former Professor of Anatomy in the Washington Medical College of Baltimore.

with the arteria innominata upon the right, and the subclavian artery upon the left side, to the great cardiac plexus.

The *external* branches unite with the three superior cervical nerves, and with the lingual, par vagum, and glossopharyngeal.

The *anterior* branches are called by Scarpa, nervi molles, from their soft texture. They are of a gray color, very numerous, and accompany the external carotid and its branches, forming plexuses around each, which are named according to the artery they surround, as the superior thyroid, facial, and lingual plexus.

The *middle cervical ganglion* is situated upon the longus colli muscle, opposite the fifth cervical vertebra, and behind the common carotid artery, resting upon the superior thyroid artery. It is smaller than the superior, of irregular form, and sometimes wanting. By Haller it is termed the thyroid ganglion. It sends off branches which ascend, descend, pass outward and inward, and communicate with the superior and inferior cervical ganglia, with the vagus, and fourth and fifth cervical nerves; it also sends down the *middle* or *great cardiac nerve* to join the cardiac plexus.

The *inferior cervical ganglion* is situated between the neck of the first rib and the transverse process of the last cervical vertebra. Instead of being single, it sometimes consists of several ganglia, behind and on either side of the vertebral artery. It also radiates branches in every direction. The *superior* connect with the middle cervical ganglion, and a considerable number ascend along with the vertebral artery, forming plexuses around it, and entering the cranium to connect with the carotid plexus. Its *external* branches unite with the three lower cervical and first dorsal nerves. Its *inferior* go before and behind the subclavian artery to unite with the first thoracic ganglia, and from its *interior*, the *inferior cardiac nerve* descends to the cardiac plexus, connecting with the vagus and recurrent. Filaments also pass from the inferior cervical ganglion to the

Thyroid Gland.—This gland is situated upon the sides of the larynx and upper rings of the trachea. It is large, and consists of two portions lying laterally, and connected across the upper part of the trachea by a middle portion called the *isthmus*. The lateral parts are termed *lobes*. This gland is of a reddish brown color, deeper in the child than in the adult, and in the female than the male. Its consistence is soft.

The *lobes* are prominent and convex, being covered by the sterno-hyoid, thyroid, and omo-hyoid muscles, platysma, fascia, and skin, lying along the side of the trachea and larynx, ascending as high as the thyroid cartilage, and connected occasionally to the base of the os-hyoides, by a slip which is thought to be muscular, and called by Soemmering *levator-glandulæ*, though its muscular character is doubted by others. Upon the left side, the lobe rests upon the œsophagus, both right and left lobes cover the carotid artery, inferior thyroid vessels, and recurrent nerve on either side of the neck.

The *isthmus* or middle lobe is sometimes wanting; at other times, instead of passing in front of the trachea, it goes behind it, and then rests upon the œsophagus. In this case, should there be enlargement, not only embarrassment, but considerable danger to both respiration and deglutition might be the result.

The thyroid gland consists of lobules, which are again divisible into cells, containing a yellow serous and oily fluid, according to some; and a viscid, transparent secretion, according to others. This body has no proper capsule, unless the cellular tissue surrounding it be regarded as such. It has no excretory duct, and, though called a gland, can have no claim to such title in the proper sense of the term.

It is largely supplied with blood-vessels. The two *superior thyroid* arteries from the external carotid, go to it from above, and the two *inferior thyroid* from the subclavian below. The corresponding veins are distinguished for their size and number.

The nerves come from the sympathetic and pneumogastric.

The lymphatics pass into the cervical glands.

The thyroid, in the infant, descends as low as the thymus gland. It not unfrequently suffers enlargement constituting the disease called *goitre*, or *bronchocele*.

Its function is yet unsettled, though it is regarded as a *diverticulum* to the cerebral circulation.

SECTION VII.

THE LARYNX, OR ORGAN OF VOICE.

The larynx is situated at the anterior part of the neck, between the tongue and trachea, surmounting the respiratory tube, and thus being connected with the organs of respiration below, as well as with the pharynx or that of deglutition above. It consists of cartilages, ligaments, muscles, vocal chords, a lining mucous membrane and glands, with blood-vessels, and nerves—thus forming a great variety of structures, and an apparatus both curious and complicated.

Cartilages.—The cartilages form the solid frame work, and constitute the basis of the larynx. They are five in number, the *thyroid*, *cricoid*, two *arytenoid*, and *epiglottis*. These, united, form the larynx, a hollow box or musical case, whose cavity is somewhat quadrangular and larger above than below.

Fig. 158.

The *thyroid* (θυρεος, shield, ειδος, like) is the largest of the cartilages, and occupies the anterior and lateral portions of the larynx. It consists of two symmetrical parts called *alæ*, which meet in front along the median line, in an acute angle forming a prominence, known under the name of *pomum Adami*. Each ala presents a broad quadrilateral plate which looks backward, and on its posterior margin, at the superior and inferior

Fig. 158 represents the Thyroid Cartilage. *a* Superior cornu. *c* Inferior cornu. *b* Ala of left side. *d* Entering angle.

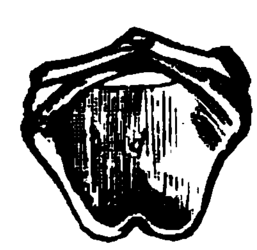
extremity has two tubercles, termed the *superior* and *inferior cornua.* Each ala has an oblique line, dividing it into two unequal parts, and giving attachment to the sterno-thyroid, thyro-hyoid, and inferior constrictor muscles of the pharynx. The superior cornua are connected by ligaments to the os-hyoides—the inferior are articulated with the cricoid.

The thyroid is open behind, and encloses the sides of the cricoid. Its *posterior* surface, behind the pomum, is concave and has attached to it the chordæ-vocales, and epiglottic ligament.

The *cricoid,* (κρικος, ring, ειδος, like,) as its name implies, is annular or ring-like in its form; it is situated at the lower and posterior portion of the larynx, giving that protection from the pressure of the parts behind, which the thyroid does from that of the atmosphere in front.

It is narrow before, and broad and vertical behind. Its *anterior* surface is convex, and has the crico-thyroid muscles attached to it. The *posterior* surface presents a depression for the *crico-arytenoidei postici,* and along its middle, a vertical ridge giving attachment to some fibres of the œsophagus. The upper margin is horizontal, and has two convex, smooth surfaces, for articulation with the bases of the arytenoid cartilages. The lower margin is circular, and connected to the first ring of the trachea.

Fig. 159.



The *arytenoid cartilages* (αρυταινα, a pitcher) occupy a vertical position upon the upper and posterior part of the cricoid. They are of a triangular shape, and are two in number. They are the smallest in size, and present an *anterior* surface, which is convex and rough, and gives attachment to the *chordæ-vocales;* a *posterior* surface, which is concave, for the reception of the arytenoid muscle; an *internal* surface, which is flat, smooth, and covered by mucous membrane, where the two arytenoids approximate; an

Fig. 160.

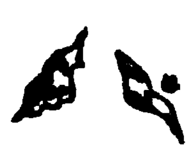
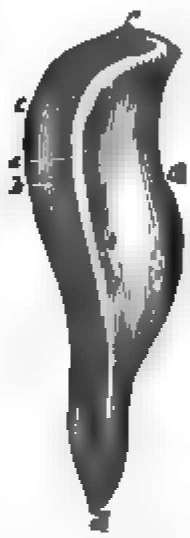


Fig. 159 represents the Cricoid Cartilage.
Fig. 160 represents the two Arytenoid Cartilages.

inferior surface, which is also smooth, but convex, constituting the *base*, and articulating with the cricoid; and an *upper extremity*, or *apex*, which is surmounted by a small movable body, called the *appendix*, or *corniculum laryngis*, also styled *tuberculum Santorini.*

The *epiglottis*—(*ἐπιγλωττὶς, upon the tongue.*)—This cartilage is situated at the base of the tongue, and is a fibro-cartilaginous structure. It occupies nearly a vertical position at the back part of the mouth. Its form is oval and flattened, having its edges curved. It is of a yellowish color, pliable and elastic. Its surfaces are *anterior* and *posterior*, or *lingual* and *laryngeal.* Both surfaces, as well as the edges, are covered by mucous membrane, which, in front, is loose, and constitutes a fold called the *frenum epiglottidis.* On the laryngeal surface this membrane is strongly attached, and presents the orifices of mucous ducts, and when removed shows the cartilage itself to be perforated. It differs from the other cartilages in never being found ossified. It is so nicely adapted to the superior opening of the larynx, as completely to close the glottis in deglutition, and thereby guard against the introduction of foreign bodies, and consequently against suffocation in the act of respiration.

Fig. 161.



Ligaments.—The ligaments, connecting the thyroid cartilage with the os-hyoides, are three in number—a *middle*, the *thyro-hyoid membrane*, which occupies the whole space, extending from the superior edge of the thyroid cartilage, to the base and cornua of the os-hyoides; and two *lateral*, the *thyro-hyoid*, extending from the superior cornua of the thyroid cartilage, to the extremities of the cornua of the os-hyoides. The *middle* ligament is a strong fibrous expansion, giving passage to the superior laryngeal nerve and artery. The *lateral* consist of round cords sometimes containing cartilaginous or osseous grains.

Fig. 161 represents a side view of the Epiglottis Cartilage. *a* Front of lingual surface. *b* Posterior or pharyngeal surface. *c* Upper margin. *d* Lower margin or pedicle. *e* Lateral portion.

The ligaments connecting the thyroid to the cricoid are also three in number, a *middle* and two *lateral*.

The *middle crico-thyroid* is a strong, yellow, and membranous ligament attached above to the lower edge of the thyroid, and below into the upper edge of the cricoid cartilage. This ligament gives passage to some small blood-vessels, and is interesting from being the place of selection for the operation of laryngotomy. The *lateral crico thyroid* ligaments consist of the capsular and synovial membranes, forming articulations between the inferior cornua of the thyroid cartilage and the sides of the cricoid.

The *arytenoid* cartilages have two sets of ligaments—the one connecting them with the cricoid, called the *crico-arytenoid*—the other with the thyroid, termed the *thyro-arytenoid* ligaments. The first set consists of two capsular ligaments and synovial membranes, by which the base of the arytenoid cartilages articulate with the superior margin of the cricoid. This articulation allows a great freedom of motion.

The second set comprises four ligaments, two *superior*, and two *inferior*. The former are sometimes called false ligaments, as they consist of little else than folds of mucous membrane, containing some delicate fasciculi of elastic fibres, which extend from the inner angle of the thyroid to the anterior face of the arytenoid.

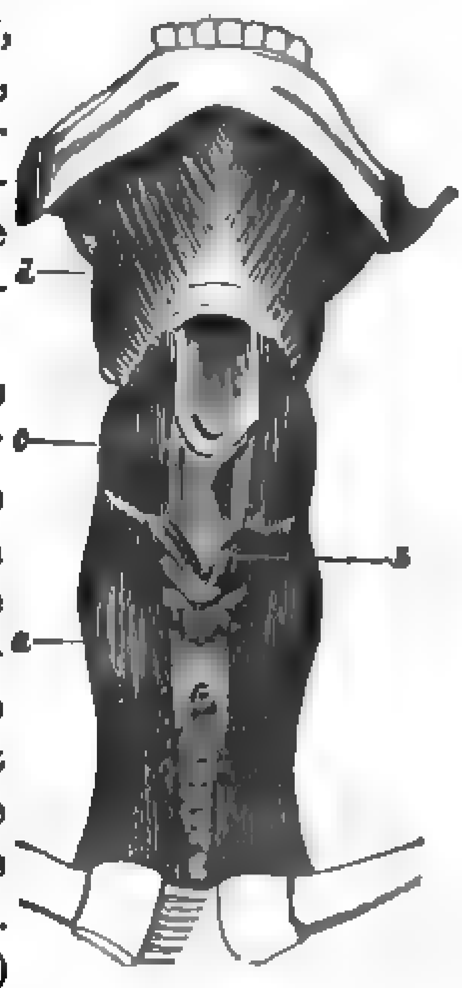
The inferior *thyro-arytenoid ligaments* are true fibrous chords, and constitute the *chordæ vocales*. They extend from the inner angle of the thyroid, horizontally backward to the base of the arytenoid cartilage. These ligaments are strong, and consist of elastic and parallel fibres which are associated with the thyro-arytenoid muscles, and pursue the same direction. The space between these inferior ligaments is the *glottis* or *rima-glottidis*.

There are two proper ligaments of the epiglottis, the *thyro-epiglottideus* and the *hyo-epiglottideus*. The former extends as a strong chord from the epiglottis to the inner margin of the thyroid notch; the latter is seen as a thin elastic membrane situated below the base of the os-hyoides

and the front of the epiglottis. The folds of mucous membrane connecting the epiglottis to the base of the tongue, have also been called ligaments—they are three in number. The middle one, called the *frenum epiglottidis*, has a few elastic fibres and some cellular tissue.

Muscles of the Larynx.—The muscles of the larynx are nine in number, eight of which are in pairs.

FIG. 162.



Dissection.—Make the same incisions as for the anterior neck, and remove the platysma, fascia, and sterno-hyoideus, and sterno-thyroideus muscles. We thus expose the anterior muscles of the larynx—which are the thyro-hyoideus and crico-thyroideus.

The *thyro-hyoideus* (Fig. 162) is a broad, flat muscle, and looks very much like a continuation of the sterno-thyroideus. It *arises* from the oblique line on the ala of the thyroid cartilage, ascends, and is *inserted* into the lower margin of the cornu of the os-hyoides and part of its base. Its function is to raise the larynx, or when the latter is fixed to draw down the os-hyoides.

The *crico-thyroideus* (Fig. 162) is a short muscle, lying below the last. It *arises* from the anterior surface of the cricoid cartilage; its fibres pass outward and upward, to be *inserted* into the inferior margin and cornu of the thyroid.

Function.—To bring these two cartilages towards each other, and thus shorten the vocal case.

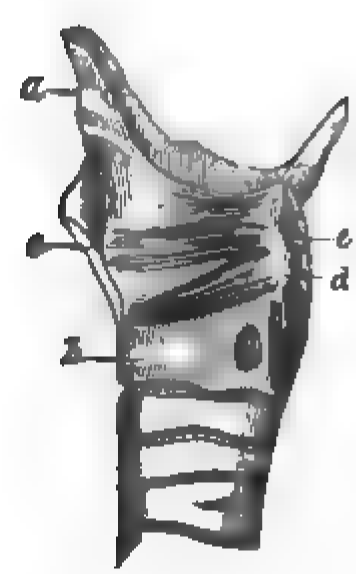
On the lateral and posterior portions of the larynx we have the *thyro-arytenoideus*, *crico-arytenoideus posticus*, *crico-arytenoideus lateralis*, *arytenoideus obliquus*, *arytenoideus*

FIG. 162 represents the Muscles in front of the Larynx. *a* Sterno thyroideus. *b* Crico-thyroideus. *c* Thyro-hyoideus. *d* Mylo-hyoideus.

transversus. To which are also added the *thyro-epiglottideus*, *aryteno-epiglottideus.*

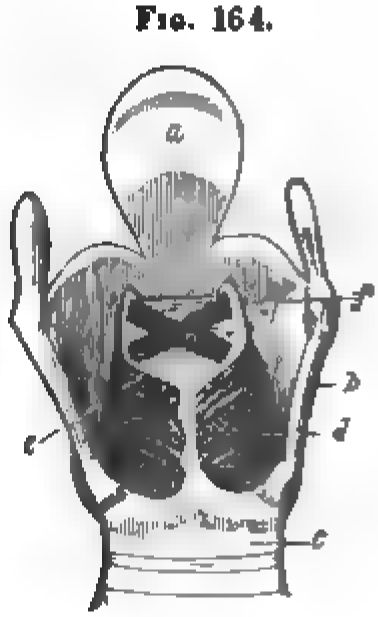
The *thyro-arytenoideus*, within the vocal case, *arises* near the angle of the thyroid cartilage on its posterior surface, and proceeds backward and outward, along the sides of the rima glottidis, to be *inserted* into the anterior and outer margin of the arytenoid cartilage. *Function.*—To bring the arytenoid cartilages forward, and thus relax the vocal chords. These muscles are regarded as the most important in the production of voice. They are concealed by the alæ of the thyroid cartilage, and are connected with and run along the vocal ligaments.

FIG. 163.



Crico-arytenoideus posticus.—*Dissection.*—Open the pharynx by a vertical incision and dissect off the mucous membrane.

FIG. 164.



This muscle will then be seen to *arise* from the posterior surface of the cricoid cartilage, and to pass obliquely upward and outward, as a flat and strong muscle, to be *inserted* into the posterior and outer part of the base of the arytenoid cartilage.

Function.—To antagonize the preceding muscle by drawing backward the arytenoid cartilages and making tense the vocal chords.

The *crico-arytenoideus lateralis*—(Fig. 163) *arises* from the side of the cricoid at its upper

FIG. 163 represents two of the Muscles of the Larynx. *a* Epiglottis. *b* Cricoid cartilage. *c* Thyroid cartilage. *d* Crico-arytenoideus lateralis muscle. *e* Thyro-arytenoideus.

FIG. 164 represents the Muscles on the posterior Larynx. *a* Epiglottis. *b* Thyroid cartilage. *c* Cricoid cartilage. *d* Crico-arytenoideus-posticus. *e* Arytenoideus transversus. *f* Arytenoideus obliquus.

edge, runs obliquely upward and backward, and is *inserted* into the base of the arytenoid. *Function.*—To draw the arytenoids outward, and enlarge the rima glottidis, as in inspiration. This is a dilator muscle.

Arytenoideus obliquus (Fig. 164) *arises* from the base of one arytenoid cartilage, and is *inserted* into the apex of the other. Its fibres are small and sometimes absent, and it is described by some anatomists as forming a part of the next muscle.

The *arytenoideus transversus* (Fig. 164) *arises* from the posterior surface of the one arytenoid cartilage, and runs transversely to be *inserted* at a similar point on the other, and filling up the concavities of each. This is a single muscle.

Function.—Both these latter muscles bring the arytenoids together, and thus close the glottis, being thereby constrictors of this opening.

The *thyro-epiglottideus* has indistinct fibres, which *arise* from the inner angle of the thyroid cartilage, and are *inserted* into the base and side of the epiglottis.

Function.—To draw down the epiglottis.

Aryteno-epiglottideus.—The fibres of this muscle are also indistinct. It *arises* from the superior extremities of the arytenoid cartilages, and passes forward and upward to be *inserted* into the sides of the epiglottis. *Function.*—The same as the latter muscle.

An *inferior aryteno-epiglottidean muscle* is spoken of by Mr. Hilton, as *arising* from the arytenoid cartilage above the vocal chords, and thence proceeding forward, over the sacculus laryngis, to be *inserted* into the side of the epiglottis. Its use, he thinks, is to diminish the cavity of this sac, and compress the adjacent mucous glands.

The conjoint action of all these muscles tends harmoniously to one common end—the production of voice; and although, to a considerable extent, they are voluntary, nevertheless the will has not perfect command over their separate actions; and, says Mr. Harrison, "those fibres which are connected with the epiglottis, and which proba-

bly minister to the function of deglutition, rather than to that of voice, appear wholly from under the influence of the will, and act in that spasmodic or convulsive motion by which the food is hurried over the glottis, and precipitated into the œsophagus."

MUCOUS MEMBRANE OF THE LARYNX AND GLANDS.

The mucous membrane of the larynx is a continuation of that lining the mouth, nose, and pharynx. It is of a pinkish color, smooth and soft, and proceeds from the base of the tongue to the anterior surface of the epiglottis, in three folds, the middle one being the frœnum. From this it passes round upon the posterior surface of the epiglottis, where it adheres pretty strongly; from this it is reflected backward to the arytenoid cartilages, constituting the *aryteno-epiglottic* folds, or, according to some, the superior or false vocal ligaments. Here it becomes continuous with the mucous membrane of the pharynx, and covers the posterior surface of the larynx. From the upper ligaments it descends within the larynx, to the inferior or true chordæ vocales, lining the intervening space, called the ventricle of Morgagni, and also an offset from this ventricle, termed the sacculus laryngis. It adheres to both these cavities loosely. Upon the inferior vocal chords it is very thin and adheres strongly, is traced downward, lining every depression and eminence, and is continuous with that found in the trachea, bronchial tubes, and air-cells of the lungs.

This membrane is perforated by a multitude of foramina, the orifices of mucous ducts. Sixty or seventy are said to belong to the sacculus laryngis. Its epithelium is found to be of the columnar form and ciliated. The ciliæ direct the secretion upward, and, according to Henle, are found extending higher up in front than upon the sides or behind. In front they reach to the posterior surface of the epiglottis, and upon the sides as high as the superior ligaments, beyond which the epithelium takes the laminated form of the pharynx and mouth. The upper portion of this membrane has great sensibility.

The *glands* of the *larynx* are distinguished into the *epiglottic* and *arytenoid.* The former are nothing more than a mass of fatty matter situated between the epiglottis and thyro-hyoid membrane. The only epiglottic glands, says Cruveilhier, belonging to the epiglottis are found within its substance, which is perforated with innumerable orifices for their reception. All of these ducts open upon the laryngeal surface and furnish a considerable quantity of mucus.

The arytenoid glands are found in the aryteno-epiglottic folds of mucous membrane, and must not be confounded with some little cuneiform cartilaginous bodies also seen in this situation.

Blood-vessels.—The arteries supplying the larynx are four in number; the two superior, and two inferior thyroid. The former come from the external carotid—the latter from the subclavian. The veins accompanying the arteries terminate in the adjoining venous trunks.

Nerves.—The nerves (Fig. 152) supplying the larynx are four in number, and all come from the pneumo-gastric or par vagum. Two are above, arise near the base of the cranium, and are called the *superior laryngeal.* The other two are below, arise from the par vagum at the root of the neck, and are called the *inferior laryngeal*, or recurrent nerves. The former chiefly supply the mucous membrane of the larynx, and are mostly nerves of sensation. The latter go principally to the muscles, and are mostly nerves of motion. For a more minute description of the blood-vessels and nerves of the larynx, see the circulation and nerves of the neck.

Relations of the *Larynx.*—The relations of the human larynx are three-fold, *physical, mental* and *organic.* The *physical* are those which the larynx has with atmospheric air in the production of voice. The *mental* are those connected with the cerebrum, as the representative and instrument of the mind, and are concerned in the intellectual functions of language and oratory; while the *organic* refer more particularly to the relations of the larynx with all the other organs of the body. By means of the pneumogas-

tric nerve, a most extensive organic connection, as already shown, is maintained between the organ of voice and the functions of digestion, respiration and circulation, through the agency of the laryngeal, pharyngeal, cardiac, pulmonary, œsophageal, and gastric branches of this pneumogastric nerve, associated with the great sympathetic of the neck, chest, and abdomen. But the most important relation of the larynx to the dentist is that which it has with the mouth.

Here the anatomical and physiological relationship is most close and important. The same mucous membrane extends from the one cavity into the other—from the mouth into the larynx. Blood-vessels and nerves, from the same sources also associate the two sets of organs, and lesion or destruction of the one, not only cripples and destroys its own functions, but also extends in greater or less degree to those of the other. For example, the loss of teeth, a cleft palate, swollen tonsils, hare-lip, &c., illustrate the injury inflicted upon the voice as well as the speech, in the subversion of the natural relations of the mouth and larynx, by this structural change in the organs belonging to the mouth.

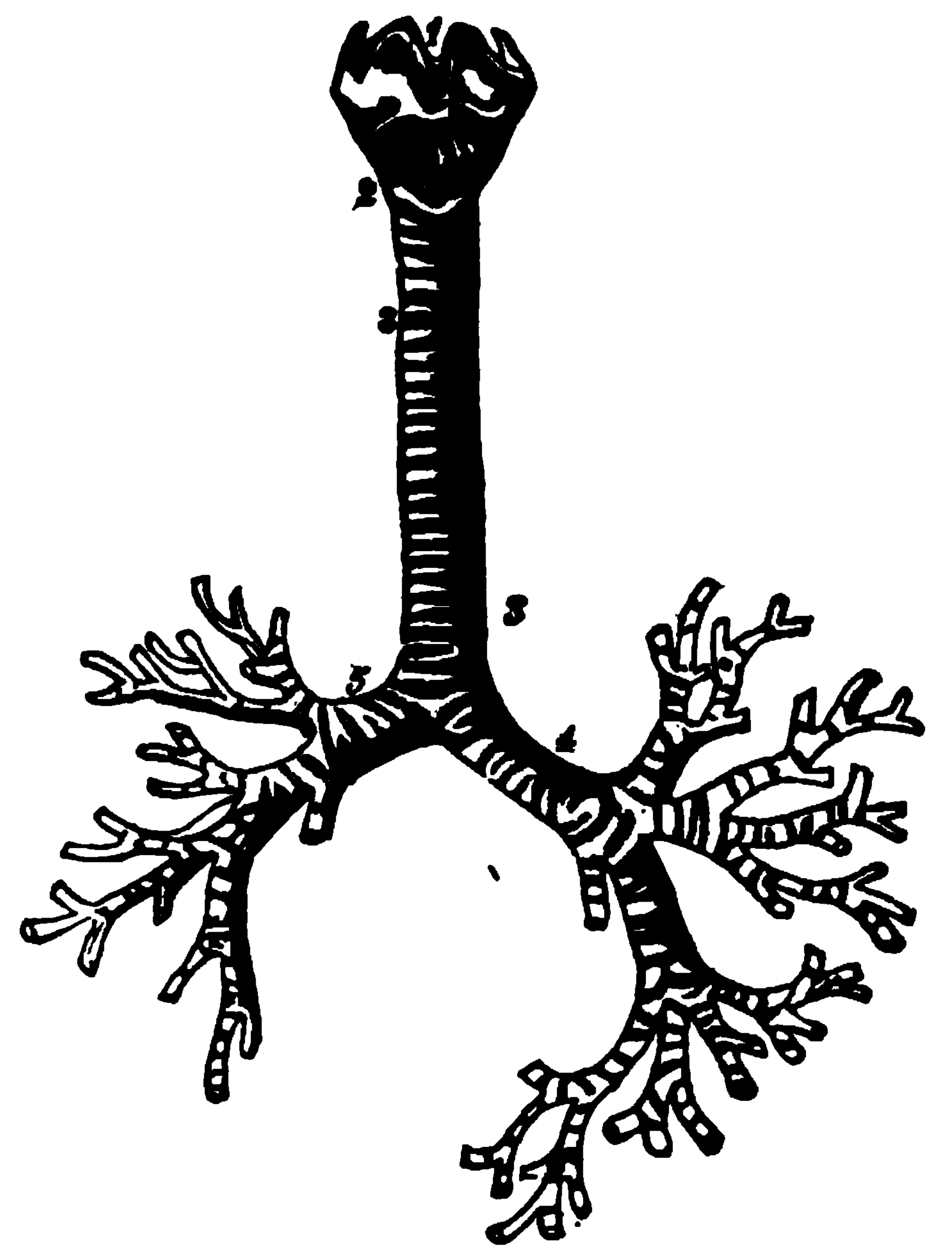
The same result would follow should the larynx be altered from its natural condition by change in any of its parts.

Trachea—(τραχυς, rough.)—The trachea (or arteria aspera) is situated upon the median line of the neck, between the larynx above, to which it is connected, and the bronchia below into which it divides. It commences about the fifth cervical vertebra below the larynx, and descends in front of the œsophagus and vertebral column, into the chest, behind the arch of the aorta, and in front of the third dorsal vertebra, where it terminates, dividing into the right and left bronchi, which go to the lungs. Its length and diameter vary according to age and sex, but the average in the adult is about five inches in length, and from three-quarters to one inch in diameter.

The *structure* of the trachea consists of cartilage, fibrous

and elastic tissue, mucous membrane and glands, with muscular fibres.

Fig. 165.



The *cartilage*, thin, flexible, readily compressed, but very elastic, assumes the *form* of flattened rings.—These rings, however, are not complete, being deficient in their posterior part, and forming only about three-fourths of a circle. They resemble in structure that of the nose and external ear more than those of the larynx. The rings run transversely, being placed one above the other, and averaging in number about eighteen. Each ring is convex externally and concave internally, enclosed within the fibrous, and lined by the mucous membrane. These cartilages preserve the trachea as a permanently open tube for the free ingress and egress of the air. Each ring is about two lines wide, an inch and a half in length, and a line in depth; their upper and lower edges are thin, and their extremities blunted. Their size is irregular, being sometimes larger in one part than another, and not always parallel. The lower cartilages are occasionally bifid, resembling those of the bronchi.

The *fibrous tissue* is regarded as the fundamental part, forming the continued tube of the trachea, being at-

Fig. 165 represents the Trachea and Bronchi. 1 Thyroid cartilage. 2 Cricoid cartilage. 3 3 Trachea. 4 Left bronchus. 5 Right bronchus.

tached above to the larynx, and continued below into the bronchi. It has the cartilaginous portion deposited in it, and forms a sheath for each particular ring, and supplying the deficiency behind, where the rings cease. This tissue is regarded as belonging to the yellow elastic, and restores the trachea, when elongated, to its natural length.

The *elastic tissue* presents the form of longitudinal bands, is found between the mucous and muscular coats, at the posterior portion of the trachea, and descends into the bronchi. The *muscular fibres* are attached to the ends of the cartilaginous rings behind—fill up their deficiency, are about half a line in thickness, and run transversely. They are exposed by dissecting off the fibrous coat, when they are seen to be thin and pale. Their *function* is to diminish the size of the trachea, and assist in expelling the mucus during expiration.

The *mucous membrane* extends from the larynx, lines the trachea, and is traced downward through the bronchial tubes in all their ramifications, as far as the air-cells of the lungs. This membrane is thin, delicate, and pale, and presents numerous foramina, the orifices of mucous glands. These *glands* are found most abundantly on the posterior surface of the trachea, situated in the muscular coat, between the muscular and fibrous, in the substance of the fibrous, and between the latter and the mucous.

They mostly present the form of small ovoid bodies, but have occasionally attained a much larger size.

The *blood-vessels* supplying the trachea come principally from the superior and inferior thyroid arteries. The veins are superficial and deep, and enter the adjoining veins. The *nerves* come from the par vagum.

CHAPTER III.

ACTIVE ORGANS OF THE TRUNK.

SECOND DIVISION.

ORGANS OF THE ABDOMEN.

The active organs of the trunk comprise, in the physiological order, most of the organs of the abdomen, which are divided into organs of digestion, and organs of absorption.

GENERAL OBSERVATIONS UPON THE ABDOMEN.

The *abdomen* (abdo, to hide) is situated between the chest and pelvis, and is the largest cavity in the body. It is bounded, anteriorly and laterally, by the abdominal muscles and fascia—posteriorly by the quadrati lumborum, psoæ muscles, crura of the diaphragm, and lumbar vertebræ—superiorly by the diaphragm, and inferiorly by the pelvis.

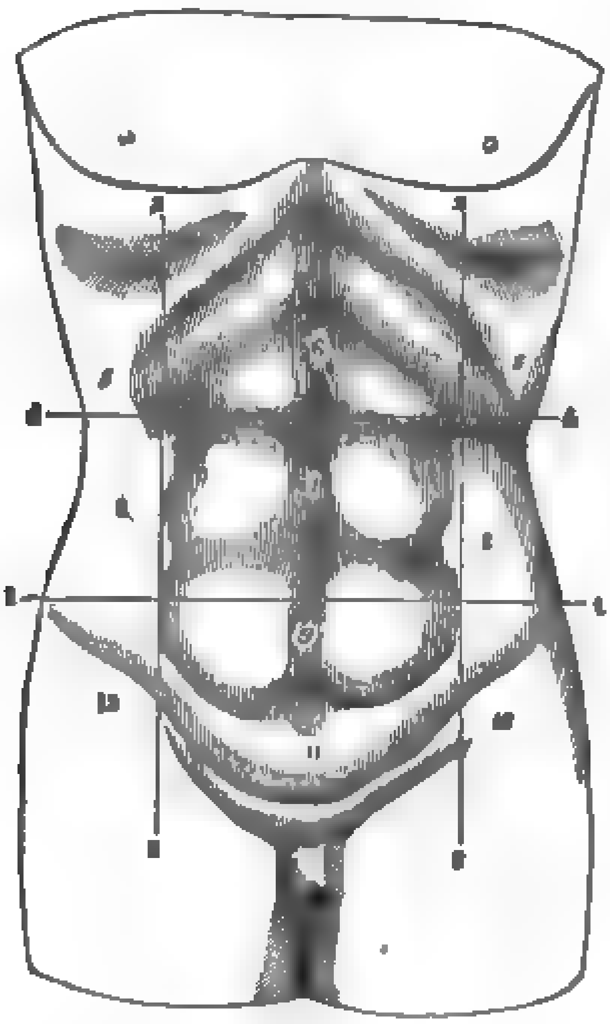
This cavity contains a variety of organs, called viscera, which, for the purpose of localizing them, as well as for the convenience of description, have determined anatomists to divide the abdomen into *regions*, (Fig. 166.)

By drawing two transverse lines across the abdomen, the one superior at the lower margin of the true ribs, the other inferior from the crista of the ilium on the one side to the same point on the opposite—then bisecting these at right angles by two vertical lines, one upon either side, and bringing them from the middle of Poupart's ligament to the cartilage of the eighth rib, then taking the anterior circumference of the abdomen, we have marked off nine regions.

Three of these occupy the middle line, and three are upon either side. The superior median region is called the *epigastric*, the central, the *umbilical*, the inferior middle, the *hypogastric* region. Those upon the sides are the right and left *hypochondriac*, upon each side of the epigastric; the right and left *lumbar*, upon each side of the umbilical; and the right and left *iliac*, upon each side of the hypo-

gastric region. Two other regions are spoken of—the one about the ensiform cartilage, called the *scrobiculus-cordis*—and the other about the symphysis pubis, called the *regio pubis*. These several regions are more or less arbitrary, and the dissector will soon find that nature does not confine herself to the limits here prescribed.

Fig. 166.



The *epigastric region* (επι, over, γαστηρ, stomach) contains most of the stomach, the solar plexus of nerves, the pancreas, left lobe of the liver, left extremity of the right lobe, and is traversed in the longitudinal direction by the aorta, thoracic duct, and commencement of the vena azygos.

The *umbilical region* surrounds the navel, and contains the upper portions of the small intestines, mesentery, and arch of the colon, covered by the omentum majus.

The *hypogastric* (υπο, under, γαστηρ, stomach,) contains the lower portion of the small intestines, the termination of the aorta, and commencement of the vena-cava ascendens.

The *hypochondriac*, (υπο, under, χονδρος, cartilage,) right and left, are on either side of the epigastric and beneath

Fig. 166 represents the Regions of the Abdomen. 1 1 A line drawn from the crest of the ilium on the one side, to the same point on the opposite side. 2 2, 3 3 Lines drawn perpendicularly from the anterior inferior spinous processes, to the cartilages of the ribs. 4 4 A line parallel to 1 1 and passing along the xiphoid, and most prominent costal cartilages. 5 5 Right and left hypochondriac regions. 6 Epigastric region. 7 Umbilical region. 8 8 Right and left lumbar regions. 9 Hypogastric region. 10 10 Right and left iliac regions. 11 Pubic region.

the cartilages. The right contains the right lobe of the liver, portion of the duodenum, and colon. The left contains the spleen, the left extremity of the stomach, part of the left extremity of the liver, and left end of the pancreas.

The *lumbar regions*, upon each side of the umbilical, contain the right and left kidneys, with the ascending and descending portions of the colon.

The *iliac* are on each side of the hypogastric; the right contains the termination of the ilium, and commencement of the colon, or caput-coli—the left has the termination of the colon, called the *sigmoid flexure.* The lower portions of the iliac regions receive the names also of *inguinal* or *spermatic.*

SECTION I.

WALLS OF THE ABDOMEN.

The *anterior* and *lateral walls* are composed chiefly of muscles and fascia.

Dissection.—Make an incision from the symphysis pubis, to the end of the second bone of the sternum. From this latter point, carry a second incision obliquely downward and outward towards the arm-pit, and onward to the spine. A third incision, commencing on the second, about the middle of the chest, and carried downward and inward towards the spine of the pubis, will be in the direction of the fibres of the superficial or external oblique muscle, at the upper part of which line the dissection should commence.

The muscles are five pair—three broad, and two narrow. The broad are the external oblique, internal oblique, and transversalis; the narrow are the rectus abdominis, and pyramidalis.

The *external oblique muscle,* (obliquus externus abdominis descendens) so named from the direction of its fibres, is the most superficial of all the abdominal muscles, and the largest. It is thin and broad, and *arises,* by fleshy and tendinous digitations, from the eight or nine inferior ribs, at their lower edges and anterior surfaces, near the car-

tilages. The five superior heads interlock with the serratus major anticus; the three inferior with the latissimus-dorsi, by which latter it is a little overlapped. The fibres of the first head blend with, and are frequently covered by a slip from the pectoralis major. At the superior part this muscle appears thin and aponeurotic, and so weak as to be not unfrequently removed, without great care in dissection. It descends in a broad, thin, aponeurotic tendon, which meets its fellow the whole extent of the linea alba, and the two together cover the whole front surface of the abdomen. The posterior and lateral portions are muscular. It is *inserted* into the linea alba, where it joins its fellow, into the ensiform cartilage, tendinous and

Fig. 167.

Fig. 167 represents the superficial Muscles of the anterior walls of the Abdomen. 1 Pectoralis major. 2 Deltoid. 3 Latissimus dorsi. 4 Serratus-major-anticus. 5 Subclavius. 6 Pectoralis minor. 7 Coraco-brachialis. 8 Biceps flexor cubiti. 9 Coracoid process of scapula. 10 Serratus major anticus, after removing external oblique. 11 External intercostal muscle. 12 External oblique. 13 Its tendon. 14 Poupart's ligament. 15 External abdominal ring. 16 Rectus-abdominis. 17 Pyramidalis. 18 Internal oblique. 19 Common tendon of internal oblique and transversalis. 20 Crural arch. 21 Fascia lata. 22 Saphenous opening.

fleshy into the anterior half of the crest of the ilium at its outer edge, and from the anterior superior spinous process of the ilium it descends in the form of a cord under the name of *Poupart's ligament*, (which ligament is regarded simply as a folding or reflection of the lower margin of this muscle,) to the spine and front of the pubis, and thence along the pectineal line forming *Gimbernat's ligament*.

When the two external oblique muscles are neatly exposed the following points are noticed, the linea-alba, umbilicus, lineæ semilunares, lineæ transversæ, and the external abdominal or inguinal ring. The *linea alba* extends from the ensiform cartilage, along the median line to the symphysis pubis. It is formed by the common union of the tendons of the oblique and transverse muscles of opposite sides, which present the form of a strong ligamentous band, whose greatest width and thickness is at the umbilicus. The umbilicus is situated at or a little below the centre of the linea alba. It is called the *navel*, and in the fœtus is a foramen through which pass the umbilical vein, arteries, and urachus. These several parts in the adult become ligamentous cords, being no longer open vessels, which, with the cellular tissue that surrounds and connects them together, and to the tendinous margin of the foramen, fill up this opening. The integument mostly containing fat in the adult, presents at the umbilicus a depression. Umbilical hernia occasionally occurs at this place. The *lineæ semilunares* are two white

FIG. 168.

FIG. 168 represents right Inguinal Hernia. *a* Inferior portion of aponeurotic tendon of external oblique. *b* Poupart's ligament. *c* Anterior superior spinous process. *d* Spine of pubis. *e* External abdominal ring. *f* Upper column of the ring. *g* Lower column of the ring. *h* Semilunar fibres of curved shape, and designed to strengthen the ring. *i* Iliac portion of fascia lata. *j* Pubic portion. *k* Saphenic opening. *l* Falciform edge.

ovally-curved lines upon each side, and about three inches distant from the linea alba, formed by the splitting of the tendon of the internal oblique, where it proceeds to form a sheath for the rectus muscle. The *lineæ transversæ* are three or four short lines, going from the linea alba transversely across the rectus muscle, to the lineæ semilunares; one of these lines is seen at the umbilicus, another at the lower end of the ensiform cartilage, a third between these two points, and sometimes a fourth midway the navel and pubis.

The *external abdominal ring* (Fig. 168) is situated in the lower part of the tendon of the external oblique, superior and external to the spine of the pubis upon each side, above Poupart's ligament. This ring (improperly so called) is triangular in form, having its base toward the pubis, and its apex external and superior. The sides of this opening are termed columns or pillars, *superior* and *inferior*. The *superior column* is broad, and its fibres go to the symphysis pubis, and decussate with those of its fellow in front of the pubis and dorsum of the penis. The inferior column, called also the pubic end of Poupart's ligament, or third insertion of the external oblique, goes to the spine of the pubis and about an inch along its crest.

This ring varies as to size; it is larger in the male than the female, its average dimensions being from an inch, to an inch and a half in the longest direction, and about half an inch transversely. This opening is very interesting from the fact of its transmitting in the male the spermatic cord and cremaster muscle, and in the female the round ligament of the uterus, and particularly so to the surgeon, from being the seat of that form of hernia called *oblique inguinal.*

Function.—The external oblique assists in expiration by compressing the abdominal viscera, which press up the diaphragm, and thus diminish the thoracic cavity. It also aids in evacuating the fœces and urine, and brings the thorax and pelvis toward each other.

Internal oblique—obliquus internus abdominis ascendens. (Fig. 167.) *Dissection.*—Remove the external oblique by an

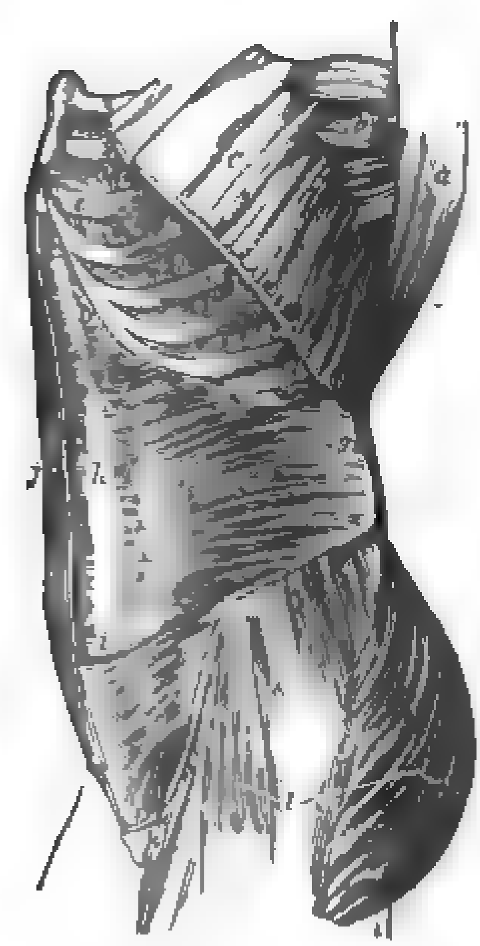
incision along the ribs, just below its origin; a second incision is to be made from the anterior superior spinous process transversely through the aponeurotic tendon of the external oblique, to the linea alba, extending the incision along the crest of the ilium. The external ring and pillars will thus be left entire for subsequent examination. Dissect from behind forward and in the course of the fibres of the muscle.

This muscle takes one of its names from the most of its muscular fibres pursuing an upward direction. It *arises* tendinous from the *fascia lumborum,* tendinous and fleshy from the whole of the crest of the ilium, and fleshy from the upper half of Poupart's ligament. The fibres of this muscle do not all ascend, those at the lower part pursue rather a transverse and downward direction. The fleshy portion is continued farther forward than the external oblique, and ends in a flat tendon, which at the outer edge of the rectus divides into two layers, one of which unites with the tendon of the external oblique to go in front of the rectus, the other joins the tendon of the transversalis and passes behind the rectus, thus forming a complete sheath for this muscle. About half way between the umbilicus and pubis, the whole of these tendons pass in front of the rectus, leaving this muscle to rest upon the peritoneum. The internal oblique is *inserted* tendinous into the ensiform cartilage, and the whole length of the linea alba, tendinous into the cartilages of the seventh and eighth ribs, and fleshy into the cartilages of the four inferior ribs. *Function.*—The same as external oblique.

Transversalis abdominis.—*Dissection.*—Remove the internal oblique by incisions from the ribs above, and crest of the ilium and Poupart's ligament below. The dissection should begin near the crest of the ilium, as here will be seen an artery, the circumflexa ilii, and some cellular tissue, showing distinctly the line of separation between the two muscles. The fibres of this muscle run transversely. It *arises* tendinous from the fascia lumborum, from the inner margin of the whole crest of the ilium, fleshy anteriorly

and tendinous posteriorly, from the external half or third of Poupart's ligament, and tendinous and fleshy from the inner surfaces of the cartilages of the six or seven lower ribs. These fibres all end in a tendon, which near the linea semilunaris, unites with the posterior layer of the internal oblique, and is *inserted* into the ensiform cartilage, the whole length of the linea alba, the upper margin of the pubis, and the linea innominata.

Fig. 169.



This tendon passes behind the rectus, except about midway between the pubis and umbilicus, where the whole pass in front. The union of this tendon with that of the internal oblique at the crista of the pubis, receives the name of the conjoined tendon which forms the floor of the external ring. *Function.*—To compress the viscera and aid in expiration.

The *rectus abdominis* (Fig. 167) is exposed by a longitudinal incision through the tendons of the broad muscles, extending from the ensiform cartilage to the pubis, and turning these tendons over to the linea semilunaris, when both the recti muscles will be seen lying side by side, along the median line. They are long and straight, thicker below than above, and *arise* by a flat tendon from the superior margin of the pubis between the symphysis and spine; the fibres ascend and are *inserted* into the ensiform cartilage, and cartilages of the fifth, sixth, and seventh ribs. The recti are about three inches in breadth, and present,

Fig. 169 represents the Transversalis Muscle. *a* Latissimus dorsi. *b* Serratus major anticus. *c* External oblique. *d* External intercostals. *e* Internal intercostals. *f* Transversalis abdominis. *g* Fascia lumborum. *h* Sheath of the rectus, its posterior part. *i* Rectus abdominis cut off, and its sheath. *j* Rectus abdominis of right side. *k* Crural arch. *l* Gluteus maximus.

three or four irregular transverse lines, which are tendinous intersections of these muscles, and called *lineæ transversæ.* Their situations correspond to the umbilicus, the ensiform cartilage, midway these two latter points, and sometimes below the navel. These lines adhere strongly to the tendons, and linea alba in front, and are not often seen on the back of these muscles. *Function.*—To bring the chest and pelvis toward each other and compress the bowels.

The *pyramidalis*, (Fig. 167,) situated at the lower part of the abdomen, is a short muscle and *arises* by a broad, fleshy, and tendinous base, from the superior border of the symphysis, extending to the spine of the pubis, having the rectus behind, and the external oblique in front. Its fibres ascend in a tapering manner, and are *inserted* into the linea alba, half way between the pubis and umbilicus. This muscle is placed in a sheath between the tendons of the broad muscles, and is not unfrequently absent. *Function.*—To assist the rectus, and make tense the linea alba.

The conjoint action of all these muscles is to lessen the cavity of the abdomen and compress the viscera, and, although they are voluntary muscles, and also aid in expiration, defæcation, vomiting, and parturition, they do sometimes act without the consciousness of the individual, and are referred to by Mr. Harrison as strong examples of the influence of the excito-motory nerves, in consequence of their sympathy with the lungs, larynx, stomach, bladder, and uterus, sympathies which cannot be traced to any direct nervous connection.

Fasciæ of the Anterior and Lateral Walls.—The fascia superficialis and the fascia transversalis.

The *superficial fascia* is sub-cutaneous, and continuous with that covering the chest. It consists of condensed cellular structure, and is variable in consistency in different parts—being weak, and cellular in some, and aponeurotic in others. It is traced over the abdominal muscles below, to Poupart's ligament, to which it slightly adheres—and thence upon the thigh for a short distance—also upon the

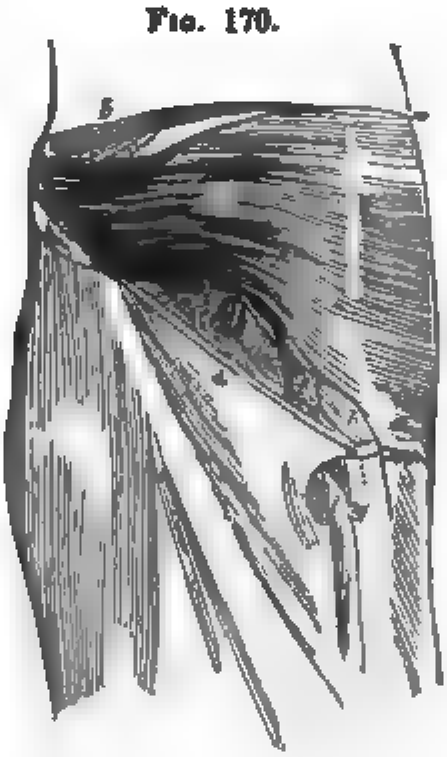
dorsum of the penis, forming a suspensory ligament. It gives covering to the spermatic cord, which descends into the scrotum, and is continuous with the fascia of the perineum. This fascia, called also *Camper's fascia*, is thin and weak above, and strong and dense below, where it envelops the glands and a quantity of adipose matter, and has hence received the additional name of *adipo-glandular* structure. About an inch below Poupart's ligament it becomes closely connected with the fascia lata, in consequence of which adhesion, femoral hernia is disposed to take the upward direction. In some of the lower animals this fascia is well developed—presents a yellowish aspect, and is very strong and elastic, by which arrangement it is well adapted to protect and support the abdominal viscera.

The fascia transversalis is situated beneath the transverse muscle, and rests upon the peritoneum. It is of varying strength and consistency at different points, being cellular in some, and decidedly aponeurotic in others. It is generally a thin tendinous membrane, distinctly fibrous and strong in each inguinal region, and closely adhering to the transverse muscle. It is attached to the inner margin of Poupart's ligament its whole length, to the crista of the pubes behind the common tendon of the internal oblique and transverse muscles, to the external margin of the rectus, thence lining the transverse muscle, and the whole of the abdomen as high as the thorax.

The lower portion of this fascia is extremely interesting from its connection with inguinal hernia. As already stated, it is here very strong and aponeurotic, and closely attached to the whole of Poupart's ligament. Dissection, however, shows that it does not stop at this ligament, but that a portion can be traced beneath the crural arch, in front of the femoral vessels, called their *anterior sheath;* and backward, as continuous with the fascia iliaca, a strong membrane covering the iliacus and psoas muscles. Where these two fasciæ meet and are united to Poupart's ligament, there is seen a white, dense line, extending, in some-

what of a curve, from the femoral artery to the crest of the ilium, enclosing the internal circumflex artery and veins. At this common point of union between these three several structures, protrusion of any of the viscera beneath the crural arch, from the femoral artery outward, is effectually guarded against both by the great strength of this union, and the firm support it gives to all the organs pressing upon this point.

Fig. 170.



From an inch and a half to two inches from the spine of the pubis, and about a half or three-quarters of an inch above Poupart's ligament, there is an opening in this fascia, called the *internal abdominal ring.* It is found about midway between the symphysis of the pubis and spine of the ilium. Through this opening the spermatic cord, or round ligament, passes out of the abdomen. The opening is not distinct, as the cord, in passing through the fascia transversalis, pushes before it a reflection from this fascia, which, from its shape, is called the *infundibuliform,* or *fascia propria.* From this internal ring or opening, to the external ring in the tendon of the external oblique muscle, there is a canal called the *oblique inguinal canal*—a distance of about eighteen lines, along which the oblique inguinal hernia descends.

This canal is bounded, in front, by the common integuments, superficial fascia, and tendon of the external oblique—behind, by the fascia transversalis, the conjoined tendons, and triangular ligament—below, by Poupart's

Fig. 170 represents the Transversalis Fascia, and internal ring. *a* Internal oblique. *b* Part of transversalis. *c* Arched border of these two muscles forming the upper boundary of the inguinal canal. *d* Poupart's ligament. *e* Fascia transversalis. *f* Conjoined tendon of internal oblique and transversalis; letters *e f* form the posterior boundary of the canal. *g* Internal abdominal ring. *h* External ring, the dotted lines show the course of the cord.

and Gimbernaut's ligaments—and above, by the fleshy margin of the transverse muscle.

BLOOD-VESSELS OF THE ANTERIOR AND LATERAL WALLS.

The arteries are external and internal. The former arise from the femoral artery, ascend over Poupart's ligament, and consist of the external or superficial circumflexa ilii, external epigastric, and external pudic, proceeding between the skin and superficial fascia, to be distributed about the spinous process of the ilium, the umbilicus, and pubis. The internal or deep arteries have the same name, the principal of which are the circumflexa ilii proper, and *internal epigastric*, both of which come from the external iliac just as the latter is passing under Poupart's ligament. The latter ascends on the pubic side of the internal ring, between the fascia transversalis and peritoneum, to the rectus muscle, upon which it ramifies and ascends to anastomose with the internal mammary, which descends from

Fig. 171.

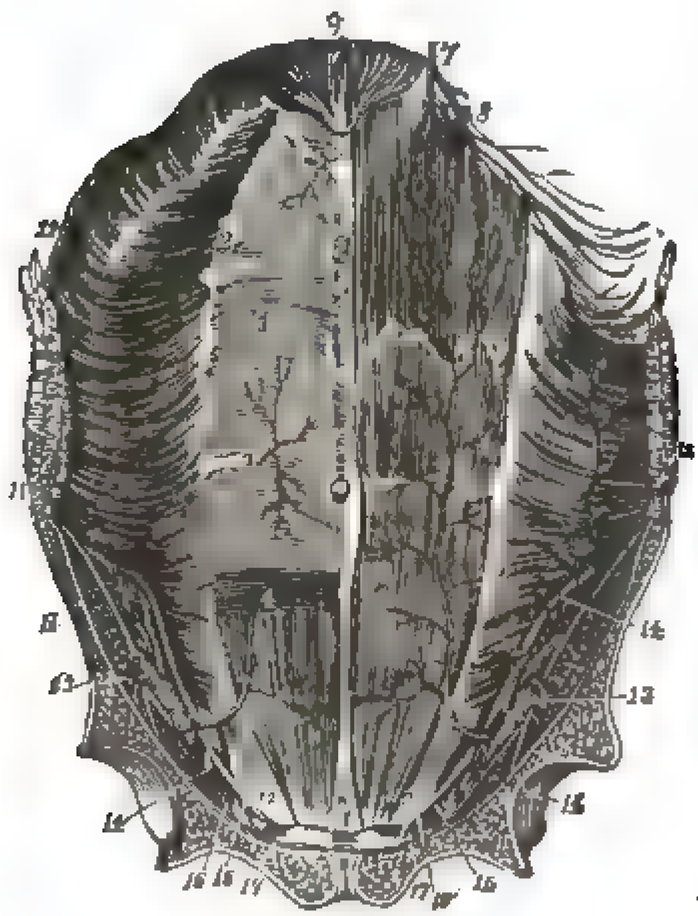


Fig. 171 represents an internal view of the Anterior Abdominal Wall, with its Blood-vessels. 1 1 Linea alba. 2 2 Linea semilunaris. 3 3 Lineæ transversæ. 4 Lower border of sheath of rectus. 5 6 Rectus abdominis. 7 Internal mammary artery. 8 Musculo-phrenic branch. 9 9 Diaphragm. 11 Section of the three abdominal muscles. 12 Section of external and internal oblique. 13 External iliac artery. 14 Circumflexa ilii artery. 15 External iliac vein. 16 Crural ring. 17 Gimbernat's ligament. 19 20 Arch formed by the lower border of internal oblique, and transversalis muscle. 22 Conjoined tendon of internal oblique and transversalis.

the subclavian to supply the anterior abdominal walls. Each artery has one or two accompanying veins which open into the femoral, saphena, iliac, and subclavian veins.

The *nerves* come principally from the lumbar plexus.

The *posterior walls of the abdomen* include muscles, fascia, blood-vessels, nerves, and lumbar vertebræ.

The muscles are quadratus lumborum, psoas magnus, psoas parvus, iliacus internus.

The *quadratus lumborum*, situated between the last rib and the ilium, and composing a great part of the posterior abdominal wall, is enclosed in a strong sheath, formed of the middle and anterior layers of the tendon of the transverse muscle. By removing the anterior layer of this sheath with the colon and kidney, the muscle is exposed. It presents an oblong form, and *arises* tendinous and fleshy from the posterior crest of the ilium and ilio lumbar ligament, and ascends to be *inserted* into the transverse processes of the last dorsal and four upper lumbar vertebræ by tendinous slips, and into the vertebral half of the last rib. *Function.*—To aid in expiration, by drawing down the last rib, and flexing the spine to one side.

FIG. 172.

FIG. 172 represents Muscles of the posterior wall of Abdomen. *a* Quadratus lumborum. *b* Iliacus internus. *c* Psoas-magnus. *d* Psoas parvus. *e* Obturator externus.

The *psoas magnus*—*ψόα*, the loins, (Fig. 172,) is round, long, thick, fleshy above, and *arises* by two planes, the first fleshy from the sides of the bodies of the lumbar and last one or two dorsal vertebræ, the second from the transverse processes of all the lumbar vertebræ; the two sets unite to form an oblong muscle, which descends along the lateral margin of the brim of the pelvis, beneath Poupart's ligament, and about its centre, and is *inserted* by a tendon common to it and the iliacus internus, into the trochanter minor, and fleshy for about an inch below into the linea aspera. A bursa is found between this tendon and the trochanter, and also between it and the pubis as it passes over. *Function.*—To flex the thigh on the pelvis, or the body on the thigh. It can also rotate the thigh outward.

The *psoas parvus* (Fig. 172) has a short belly and a long tendon. It arises fleshy from the sides of the bodies of the last dorsal and first lumbar vertebræ, and from the intervertebral ligament. Its tendon begins about the fourth lumbar vertebra, and passes down to be inserted into the linea innominata, and by a broad aponeurotic expansion into the fascia iliaca. This muscle is situated at the anterior and internal edge of the psoas magnus, and is often wanting. *Function.*—To flex the body or raise the pelvis, and draw up the sheath of the femoral vessels, which, it is thought, in sudden flexion will lessen the liability to injury of these vessels.

The *iliacus internus* (Fig. 172) is situated on the outside of the psoas magnus, and fills up the venter of the ilium. It *arises* fleshy from the last lumbar vertebra by its transverse process, from the ilio-lumbar ligament, inner margin of the crista ilii, venter of the ilium, and intervening notch between the two anterior spinous processes of the ilium—also from the capsule of the hip joint. It unites with the tendon of the psoas magnus, and is *inserted* along with it into the trochanter minor. A large bursa is found between this common tendon and the capsule of the hip joint, which occasionally communicates with the cavity of the joint.

Function.—The same as the psoas magnus.

FASCIA OF THE POSTERIOR WALL.

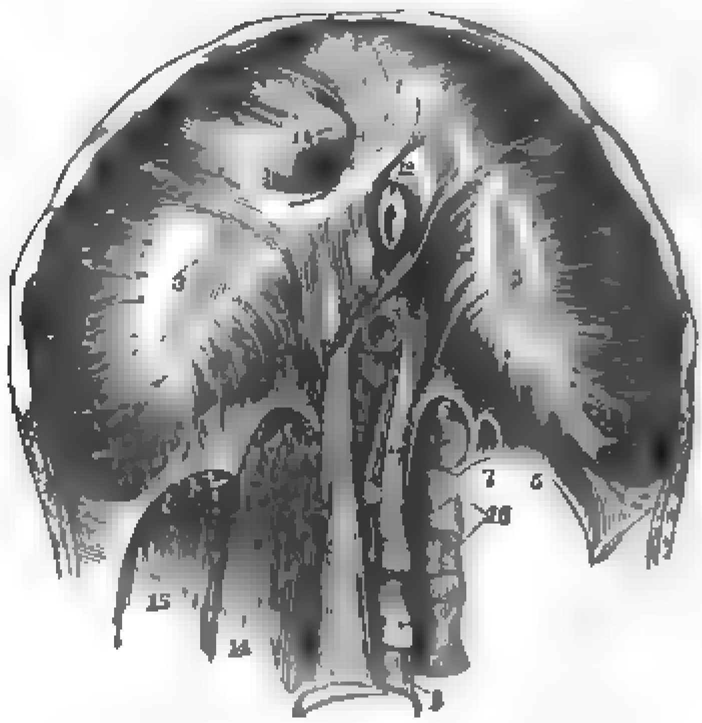
Fascia iliaca.—This fascia, called also lumbo-iliac aponeurosis, occupies the iliac region, and may be traced as a strong membrane covering the iliacus and psoas muscles, connected with Poupart's ligament from the anterior superior process of the ilium as far as the external iliac artery, where it passes beneath this vessel upon the thigh, forming the posterior sheath of the femoral vessels, and being continuous with the pectineal portion of the fascia lata. Along Poupart's ligament it is also connected with, and continued into the fascia transversalis. The fascia iliaca can be followed below into the pelvic fascia; above, after covering the psoas and iliacus muscles, as high as the diaphragm, it is connected to the ligamentum arcuatum and sides of the lumbar vertebræ, where it forms a series of arches for the passage of the lumbar vessels and some of the nerves.

This fascia has the double use of giving strength to the lower part of the abdomen by its firm union with Poupart's ligament, and of furnishing a strong covering to the psoas and iliacus muscles. With the fascia transversalis, it also forms a sheath for the femoral vessels at the upper part of the thigh. At this point these two fasciæ are still further connected by two vertical partitions, one of which is between the femoral artery and vein, the other between the vein and the femoral or crural ring.

Superior wall of the abdomen, (the diaphragm.)—Dissection.—To expose this muscle, the abdominal viscera should be removed, and the loins raised by placing a billet of wood beneath the lumbar vertebræ. Then, dissecting off the peritoneum from the lower surface, the diaphragm will be seen as a movable curtain, dividing and separating the abdominal and thoracic cavities. This muscle is broad, and somewhat circular in its shape, consisting of a fleshy and tendinous portion, and presenting two surfaces—a superior and inferior, or thoracic and abdominal, the upper surface being convex, the lower concave. The diaphragm

is generally divided into two portions, called the *greater* and *lesser* diaphragm.

Fig. 173.



The greater *arises* fleshy from the posterior part of the ensiform cartilage, from the inner surface of the cartilages of the seventh true, and all the false ribs, and for some extent from the osseous portion of the last two ribs. This origin, including almost a circle, indigitates with the transversalis muscle. Between the ensiform cartilage and the ribs there is a triangular space containing cellular and fatty matter, and giving passage to the internal mammary vessels, in which there is occasionally found an opening through which some of the abdominal viscera pass into the chest, constituting hernia. From the circumference of this greater muscle of the diaphragm, the fibres radiate or converge to a central tendon called the *cordiform tendon.* This tendon, which has been compared to the heart of a playing card, is a tendinous expansion of considerable extent, and of silvery whiteness, having its notch toward the spine and its apex to the sternum. All round its circumference the muscular portion of the diaphragm is attached to it. The *lesser diaphragm* consists of two crura, right and left, which are situated upon each side of the lumbar vertebræ. The

Fig. 173 represents the Diaphragm or superior wall of the Abdomen. 1 2 3 Greater muscle of the diaphragm. 4 Space where hernia sometimes occurs. 5 Ligamentum arcuatum. 6 Origin of psoas-magnus. 7 Opening for lesser splanchnic nerve. 8 One of the crura of the diaphragm. 9 Fourth lumbar vertebra. 10 Another of the crura of the diaphragm. 11 Opening for the aorta. 12 Opening for the œsophagus. 13 Opening for the ascending cava. 14 Psoas magnus. 15 Quadratus lumborum.

right crus is the larger of the two and *arises* tendinous from the sides and anterior surface of the four upper lumbar vertebræ and their intervertebral ligaments; the left crus, being the smaller, comes from the two upper vertebræ. Both crura ascend and are connected upon the last dorsal vertebra by a tendinous cord, semilunar in shape, which arches over the aorta and thoracic duct. A little above this point the crura approach each other and decussate, and pass on to be *inserted* into the notch and posterior margin of the central cordiform tendon. The greater and lesser muscles of the diaphragm have their attachments completed by the *ligamentum arcuatum*, which extends from the transverse process of the first lumbar vertebra, and body of the second, to the twelfth rib. To the upper margin of this tendon the diaphragm is attached, and to its lower margin the psoas magnus muscle, and under it is placed the sympathetic nerve. The diaphragm contains three large openings; one, for the aorta, thoracic duct, and great splanchnic nerves, is a long elliptical foramen, situated between and behind the crura, and in front of the bodies of the last dorsal and three upper lumbar vertebræ. The second opening is about three inches above and to the left of the aortic. Its form is that of a long oval, situated in the posterior part of the muscle, between the spine and notch of the tendon, the decussating fasciculi forming its parietes and separating it from the aortic. The œsophagus and eighth pair of nerves pass through this foramen. The third opening is for the *vena cava* ascendens. It is a large foramen a little higher than the œsophageal, situated to the right and in the back part of the cordiform tendon. It is something of a quadrilateral figure, having its margins tendinous all round, with fasciculi passing upon the vein above and below, and thus affording an arrangement by which it is kept constantly open, and all interruption to the circulation prevented.

The *blood-vessels* of the diaphragm are the *phrenic*, the first branches of the aorta after entering the abdomen, the internal mammary, intercostals, and branches from the renal and lumbar arteries. The veins open either into the

cava or contiguous veins which pass into the same trunk. The *nerves* are numerous, supplying the diaphragm, and come from the phrenic, pneumogastric, spinal, and sympathetic.

Function.—This muscle is an important agent in respiration. By its contraction its convex surface descends, and thus the diameters and cavity of the chest are enlarged and more air allowed to enter the lungs in respiration. By its contraction it also acts in concert with the abdominal muscles in vomiting, expelling the fæces, and in parturition. By its relaxation the diaphragm ascends into the cavity of the chest, diminishes this cavity and thus aids in expiration. The inferior wall will be examined in another place.

SECTION II.

ORGANS OF ABDOMINAL DIGESTION.

These comprise, 1. The organ of *chymification*, consisting of the *stomach;* 2. The organs of *chylification*, composed of the *small intestine* and the *large intestine*, which however more properly belongs to the function of *fæcation;* 3. Assistant organs of *digestion*, composed of the *liver*, the *pancreas*, and the *spleen*.

Before giving the description of the abdominal viscera separately, it is necessary first to premise a few general observations upon the *peritoneum*, a membrane which is common to each and the whole, and which forms the lining membrane of the abdominal walls.

Peritoneum, (περιτεινειν, to extend around.)—The peritoneum is a serous membrane, and the largest one in the body. Like all serous membranes, it is a shut sac. This is true of the male peritoneum, but in the female there is an opening at the extremities of the Fallopian tubes, which Mr. Harrison observes is more apparent than real, for he thinks it probable that these fimbriæ are closed at all times except when in contact with or adhering to the ovaries. Thus, in ascites, the water is never found escaping by these openings, nor air, nor fluid, when injected in the dead

body; and if such be the facts, the female peritoneum can scarcely be said to form an exception to the general rule of all serous membrane, in being a shut sac. Its *structure* is the same as all other serous membranes, being composed of an external layer of cellular tissue, and an internal one, which is pearly in appearance, smooth, semi-transparent, and by the microscope is shown to consist of laminæ of flattened vesicles, with central nuclei. The external layer is connected with the surrounding structures, and conducts the nutrient vessels and nerves. The peritoneum has two great divisions, the one lining the abdominal walls and called its *parietal;* the second reflected over the viscera, and called its *visceral* portion. As

FIG. 174.

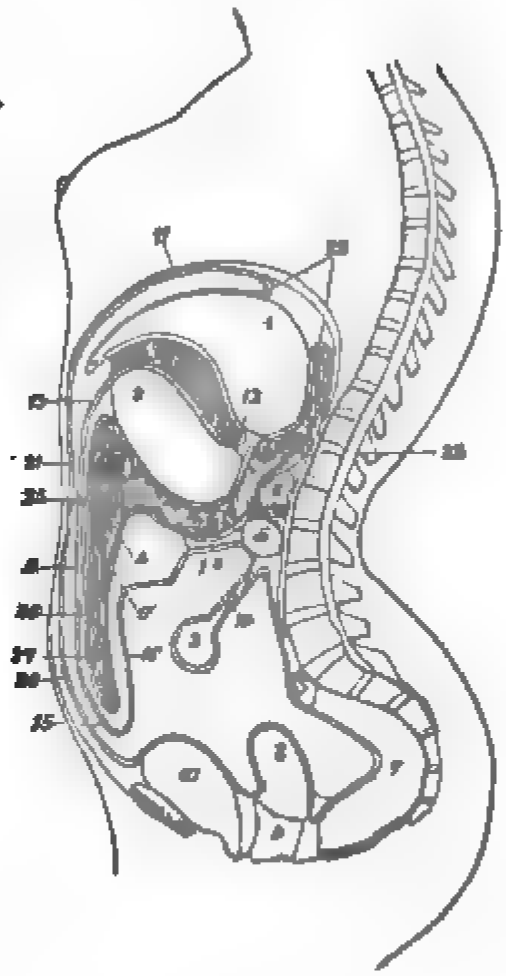


FIG. 174 represents the Reflections of the Peritoneum. 1 Liver. 2 Stomach. 3 Small intestine. 4 Arch of the colon. 5 Duodenum. 6 Pancreas. 7 Rectum. 8 Uterus. 9 Vagina. 10 Bladder. 11 Peritoneum reflected from diaphragm to Liver, and thence to the lesser curvature of the stomach, forming the anterior layer of the omentum minus, then 12 covers anterior face of stomach, and at 13 14 descends to form the omentum majus; at 15 it is reflected upward, forming at 16 the posterior layer of this latter omentum; at 17 it surrounds the transverse colon, and extends back to the spine, forming at 18 the mesocolon; it now goes in front of the duodenum 5, and descends to the small intestine 3, which it surrounds and furnishes the mesentery; it next descends the posterior abdominal wall, covering the rectum 7, in front, the uterus 8, bladder 10; and then ascends covering the anterior abdominal wall 20 and 21, to the diaphragm, place of beginning, at 22. If we start again from the diaphragm, we follow the peritoneum forming at 23, the posterior layer of lesser omentum, and at 24 the posterior layer of the stomach, and thence downward, forming, at 25 and 26, the posterior layer of the anterior fold of omentum majus, and then turns up at 27 to constitute the anterior layer of omentum, which goes to the anterior surface of the colon 4, and at 28 forms the anterior surface of the meso-colon, which is traced up to the pancreas 6, and on to the place of beginning.

this membrane is a shut sac, it is immaterial where we commence tracing it, as we must necessarily return to the place of beginning. If we start at the umbilicus, we follow it ascending upon the internal surface of the anterior abdominal walls, to the diaphragm, upon the lower surface of which it is reflected. From the diaphragm it passes on the left side upon the spleen, on the right to the liver, and in the centre upon the stomach. In this course from the umbilicus there is also a distinct reflection to the convex surface of the liver, called the *suspensory* or *falciform* ligament, which receives the ligamentous remains of the umbilical vein. There are other reflections of this membrane upon the liver, which will be noticed in the separate description of this viscus. From the liver, after investing both surfaces, it is traced from the transverse fissure downward to the lesser curvature of the stomach. This reflection is called the *lesser omentum*, or *gastro-hepatic* omentum, and encloses the hepatic vessels; at the lesser curvature of the stomach, the two laminæ of this omentum separate, the one to pass in front of, and the other behind the stomach, to meet again along the greater curvature, thus completely investing this organ, except at the upper and lower curvatures, where this membrane separates and again unites. From the greater curvature of the stomach, the peritoneum descends to the lower part of the abdomen, and then turning upon itself, ascends to the arch of the colon, thus making this reflection to consist, by its duplication, of four laminæ. It is called the *omentum majus*, or *gastro-colic omentum*.

At the colon it again separates to enclose this intestine, and, upon the concave portion, unites to pass to the spine, forming another reflection, called the *transverse mesocolon*, which divides the abdominal cavity into two parts—superior and inferior. From the spine the transverse mesocolon separates into an ascending and descending portion. The former is traced upward, over the lower part of the duodenum and the pancreas, to the posterior part of the right lobe of the liver, where it is continuous with the peritoneum of this organ, and the posterior layer of the lesser

omentum. The lower or descending layer passes over the small intestines, and round these and their vessels, to form a double lamina, which returns to the spine, forming a very broad and important reflection, termed the *mesentery*. The mesentery, besides blood-vessels, also encloses numerous lymphatic glands and absorbents. From the root of the mesentery we find its laminæ stretching, upon either side, into the lumbar regions upon the right and left colon, constituting the *right and left mesocolons*, into the iliac regions, and thence into the pelvis, upon the rectum, forming the *meso-rectum*. From the rectum, of which it does not cover more than its upper two-thirds, it is reflected, in the male, upon the posterior and lower part of the bladder, forming two lateral folds, called the posterior ligaments of the bladder, between which there is a depression or cul-de-sac.

In the female this reflection passes first to the posterior and upper part of the vagina, then spreads over the uterus and to either side, forming the *broad ligaments*, which enclose the Fallopian tubes, ovaries, and round ligaments. From the front of the uterus the reflection proceeds to the bladder, and then ascends, as in the male, upon the sides and posterior surface of the bladder, to its fundus, whence it is traced upward, upon the posterior abdominal walls, to the umbilicus—the place where it was first opened.

In this tracing of the peritoneum, it is seen that it only gives a partial covering to many of the organs—as the duodenum, rectum, bladder, kidneys, &c.; that all the viscera, even those having the most complete investment from it, are upon its external surface, and not within its cavity; and that each organ gets its covering by simply pushing this membrane before it into the peritoneal sac. A familiar illustration is found in the double night-cap, showing how a shut sac may invest any thing, yet be on its outside. The portion of the cap covering the head, resembles the peritoneum, covering the viscera, while the loose part of the cap, above the head, resembles the reflected portion of the peritoneum, upon the abdominal walls.

About the neck of the gall-bladder, and at the base of

the lobulus Spigelii, is seen a large opening, called the *foramen of Winslow.* It is by this foramen that the cavity of the omentum communicates with the cavity of the peritoneum. If air be forced into this opening, it is found to pass behind the stomach, and fill the cavity of the omentum. Dr. Hodge, of Philadelphia, appears to be the first who has suspected the true use of this foramen, which is to introduce this lining lamina of the great omentum, so as to make it duplicate throughout. *Function.*—The peritoneum connects the several abdominal viscera, and retains them in their natural positions. It also conducts the various blood-vessels and nerves, and secretes a fluid by which its surfaces are lubricated, and friction diminished.

THE STOMACH—(VENTRICULUS.)

The stomach receives the masticated and insalivated food from the œsophagus.

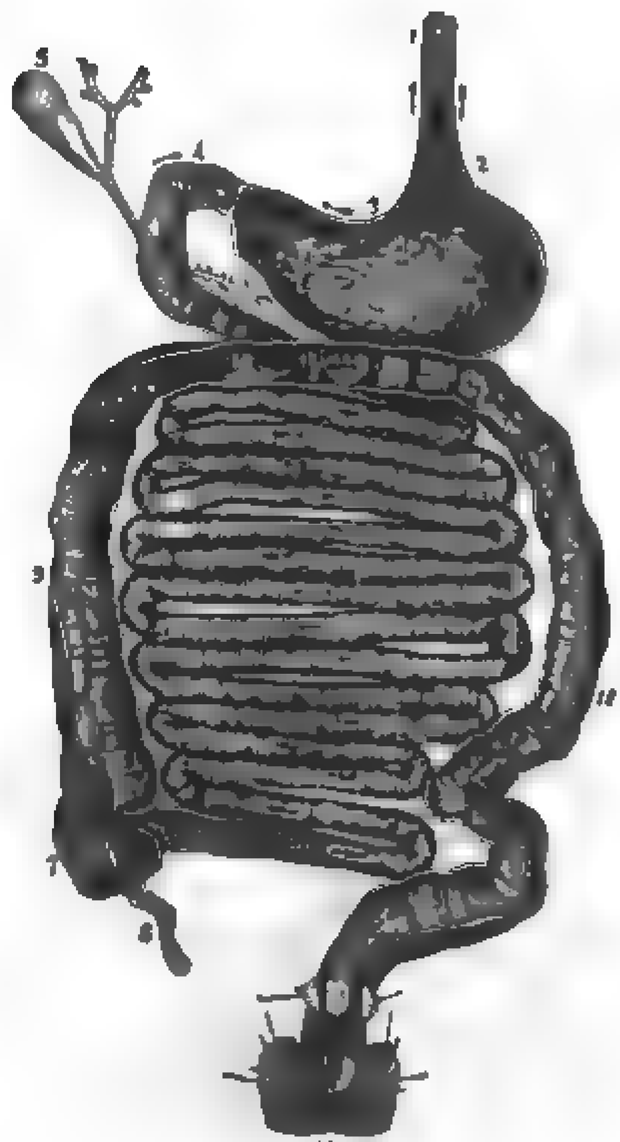
This organ presents the largest dilatation of the alimentary canal. It occupies the epigastric, left hypochondriac, and part of the right hypochondriac region, lying between the œsophagus on the left, and the duodenum on the right, with each of which it is inseparably connected. It has still further connections, by means of the peritoneum, to the diaphragm and liver above, through the reflection of the omentum minus; below, to the arch of the colon, by the omentum majus; on the left, with the spleen, by the omentum gastro-splenicum.

Its shape is somewhat conoidal, with the base on the left side, whence it extends obliquely downward and forward, across the epigastric region, to terminate on the right side, near the gall-bladder, in the duodenum. It presents two surfaces, two curvatures, two orifices, and two extremities.

The surfaces are *anterior* and *posterior.* In the distended state of the stomach, the anterior surface becomes superior, and looks towards the diaphragm, being in contact with the ribs and left lobe of the liver. The posterior surface presents towards the spine. The curvatures are superior and inferior, or lesser and greater. The *lesser* extends

between the œsophagus and pylorus—presents upward and backward, and receives the omentum minus. The *greater* looks downward and forward, and has the omentum majus attached to it. Along these curvatures, the stomach is not covered by the peritoneum, and it is at these points that the separation of the omentum occurs, and allow of that expansion of the stomach, in a state of distension, which it is believed to be their function to afford.

FIG. 175.



A variety of opinions have been entertained in reference to the use of the omentum majus, into which we shall not stop to inquire, and will simply remark, in addition to what has been already said, under the head of peritoneum, that both its position and density vary very much. At one time it is found spread out as an apron, over the intestines, and at another, tucked up and hid by the stomach. At one time it is very thick, from being loaded with fat—while at another, it is entirely destitute of adipose matter, and extremely thin and transparent.

FIG. 175 represents the Stomach and Intestinal Tube. 1 Œsophagus laid open. 2 Cardiac orifice of stomach. 3 Interior of stomach. 4 Duodenum commencing at the pyloric orifice of stomach. 5 Gall bladder. 6 6 6 Small intestine. 7 Cœcum or beginning of large intestine. 8 Appendix vermiformis. 9 Right ascending colon. 10 Transverse colon. 11 Left descending colon. 12 Sigmoid flexure. 13 Rectum. 14 Anus.

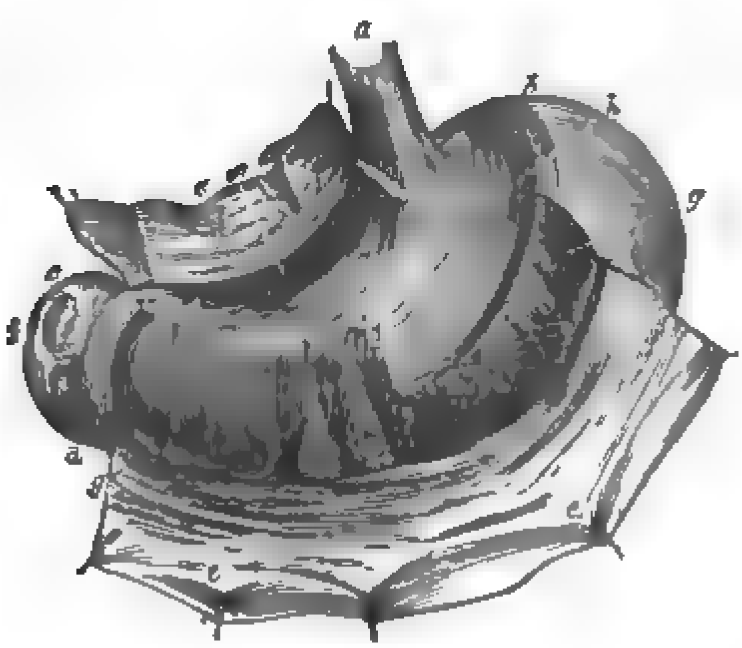
The orifices of the stomach are the *cardiac* and *pyloric*. The *cardiac* is on the left side, and forms the termination of the œsophagus in the stomach. The *pyloric* is on the right side, and forms the entrance to the duodenum. It is lower than the cardiac, and is readily recognized by a circular thickening of the parts.

The extremities of the stomach are a *greater*, which is in the left hypochondrium, and comprises what is termed the great cul-de-sac, which is situated to the left of the œsophagus, and in front of the spleen. The *lesser* is the pyloric extremity, which is to the right, much smaller than the left, of a cylindrical shape, and extends to the gall-bladder.

The size of the stomach varies in different individuals, and in different conditions of fullness or emptiness. Its average capacity is estimated at about one quart.

Structure.—The stomach consists of membranous tunics or coats, blood-vessels, and nerves. The proper coats are three, a serous, muscular, and mucous, to which is added the cellular, called the *fibrous* or *nervous coat*. The *serous coat* has been already described as being a reflection of the peritoneum, coming from the omentum minus, and forming a complete investment of the stomach, except at its curvatures.

Fig. 176.



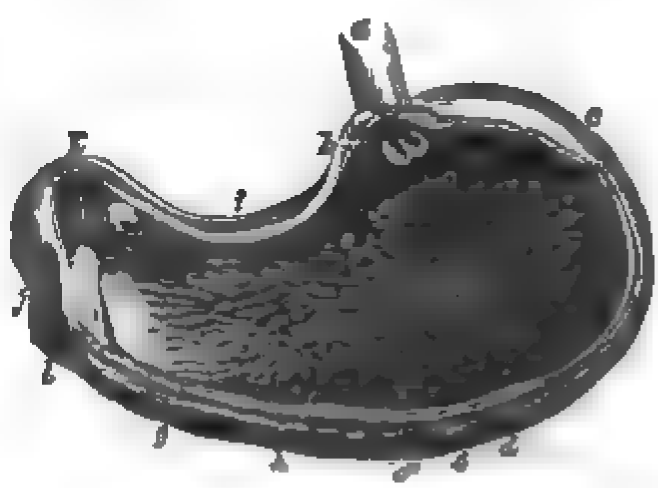
The *muscular coat* presents three layers of fibres, which are usually pale, though variable as to color. The first

Fig. 176 represents the Coats of the Stomach. *a* Œsophagus. *b* Cul-de-sac of stomach, or greater extremity. *c* Pyloric extremity. *d* Duodenum. *e e* Peritoneal coat turned back. *f* Longitudinal fibres of muscular coat. *g* Circular. *h* Oblique fibres. *i* Portion of muscular coat of duodenum.

layer is longitudinal; it is seen by raising the serous coat, is external, and extends from the œsophagus, with the fibres of which it is continuous, and thence radiates towards the pylorus, being found, in greatest abundance, along the lesser curvature, though also seen upon the greater curvature and extremity. The second, or middle layer, is circular, commencing at the cardiac end, and increasing, in the strength and number of its fibres, as it proceeds to the pylorus. The fibres of the third or internal layer take an oblique course, are most distinct on the great extremity, and spread over the anterior and posterior surfaces of the stomach.

The third or proper coat of the stomach, is the *internal*, *mucous*, or *villous*. This is connected to the muscular by an intervening structure, termed nervous or fibrous, which consists of fibres closely united, dense and strong, and regarded as the framework of the mucous membrane, to which it gives support, and conducts its blood-vessels and nerves. The mucous membrane is a continuation of that lining the œsophagus, and, according to the observations of Dr. Beaumont, is constantly covered with a viscid, transparent mucus. In its natural state it is of a light or pale pink color, varying, however, with the fullness or emptiness of the stomach. It has a soft, velvet-like appearance, whence its name the *villous coat*.

Fig. 177.

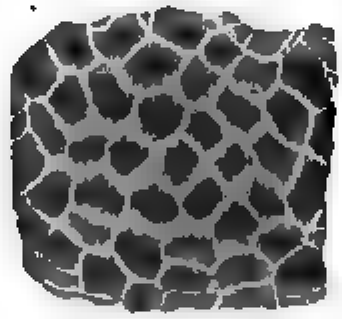


When deprived of its mucus, by washing, and examined with the microscope, in water, it presents a honeycomb

Fig. 177 represents the Interior of the Stomach. *a* Œsophagus. *b* Cardiac orifice of the stomach. *c* Its cul-de-sac. *d* Greater curvature. *e* Where omentum majus is attached. *f* Muscular coat. *g* Cut edge of mucous coat. *h* Rugæ of mucous coat. *i* Lesser curvature. *j* Where duodenum begins. *k* Pyloric orifice and valve. *l* Duodenum.

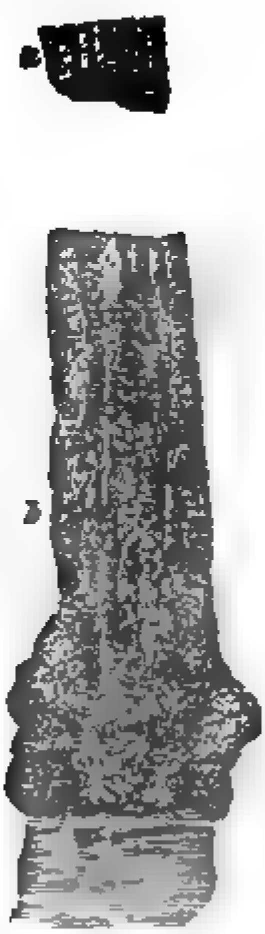
appearance, exhibiting numerous depressions, which are termed gastric pits, or favuli. These pits are surrounded by ridges, forming septa between them, which septa are

FIG. 178.



described as consisting of condensed cellular tissue, and containing mucous follicles, and many vessels. Each of these gastric pits is studded with foramina, four or five in number, which are regarded as the orifices of the ducts, leading from the glands, which furnish the gastric juice. These gastric glands consist of cœcal pouches, or follicles, situated in the sub-mucous tissue; and of tubes, some of which are short and straight, others

FIG. 179.



longer and convoluted, all closely applied together, and terminating, by the above foramina, in the gastric pits.

Mr. Beaumont observes that "when aliment or any irritant is applied to the surface, innumerable lucid points and fine nervous or vascular papillæ can be seen, arising through the mucous coat, from which distils a pure, limpid, colorless, slightly viscid fluid. This is invariably acid. The mucus of the stomach is less fluid, more viscid, semi-opaque, a little saltish, and has no acidity. The gastric fluid is never accumulated while fasting, and is seldom, if ever, discharged, except under the excitement of food, or some irritant. It is secreted only in proportion to the quantity of food supplied, provided there is not more of the latter than the system requires; and if an excess of food be taken, the residue either remains in the stomach, or passes into the bowels in

FIG. 178 represents the Gastric Favuli on the inner coat of the stomach.
FIG 179 represents the Gastric Glands or Follicles. *a* Glands magnified three times. *b* Magnified twenty times.

a crude state." The free acid of this fluid is the hydrochloric,* which, in combination with a peculiar animal matter, called *pepsin*, is believed to constitute the proper digestive principle. So potent is this principle represented, that the sixty-thousandth part, in acidulated water, imparts to it digestive properties.

The mucous coat also presents numerous rugæ, folds or wrinkles, which are irregular in their course, size, and shape. The most prominent run in the long diameter of the stomach, and nearly parallel. They are most distinct about the pylorus. The texture of this coat is soft, easily torn, and loose. It is covered by epithelium, which is more delicate, thinner, and softer, than that of the pharynx or œsophagus with which it is continuous, and, unlike these, has the cylindrical instead of the laminated form.

Where the stomach ends in the duodenum, the mucous coat forms a fold called the *pyloric valve;* around this valve the circular fibres of the muscular coat collect in the form of a bundle, and constitute a sphincter muscle, upon which depends all the efficacy of this valve in closing the opening from the stomach into the duodenum. About both extremities of the stomach, the mucous coat contains glands which resemble those of Brunner. They are thought to furnish mucus.

Blood-vessels of the Stomach.—The arteries are the *gastric* or *coronary*, which comes from the cardiac axis, and runs along the upper curvature; the *right* and *left epiploic*, and the *vasa brevia*, which come from the hepatic and splenic arteries. The *epiploic* arteries run along the greater curvature, anastomosing and radiating in every direction, while the *vasa brevia*, which are five or six small branches from the splenic, pass to the left or greater end of the stomach.

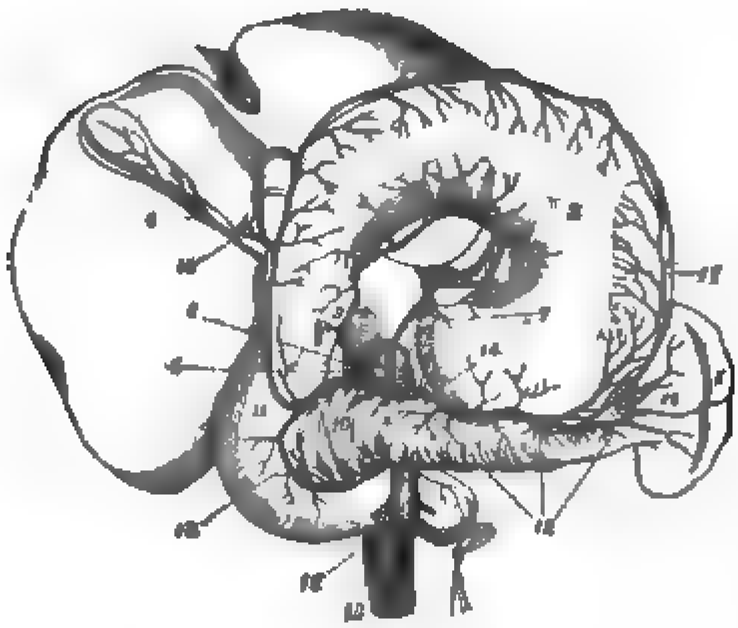
The corresponding veins enter into the *vena portarum*. The nerves are the *pneumo-gastric*, and the *sympathetic*. The former form a plexus around the cardiac orifice and ex-

* Lehmann, Bernard, and Baneswil affirm that the free acid is *lactic*. Prout, Dunglison, Enderlin, Leibig, Bence Jones, and Graham, say that it is the hydrochloric.

pand upon the anterior and posterior surfaces. The latter come from the solar plexus, and accompany the arteries. The *lymphatics* are numerous and traced to the glands along the curvatures.

Function.—The stomach is the organ in which and by which is performed the first and most important step in digestion, the conversion of the food into a soft grayish homogeneous, and slightly acid fluid called *chyme;* this change is effected through the agency of the gastric fluid, which is brought into contact and thoroughly blended with every particle of aliment, by means of the motion communicated to both through the muscular apparatus of the stomach.

FIG. 180.



THE INTESTINES, (Fig. 175.)

The intestines comprise the whole of the alimentary canal, from the stomach to the anus. The length of this canal averages from thirty to thirty-five feet, though it measures more when separated from its connections and stretched out. Its size varies, and its shape is cylindrical. The intestines are divided into the *small* and *large* intestine.

The small intestine is subdivided into the *duodenum*, the *jejunum*, and the *ilium*.

The large intestine into the *cæcum*, the *colon*, and the *rectum*.

FIG. 180 represents the Arteries of the Stomach and its relation to the liver, pancreas, spleen, and duodenum. 1 Liver. 2 Stomach. 3 Duodenum. 4 Pancreas. 5 Spleen. 6 Cardiac artery. 7 Gastric artery. 8 Hepatic artery. 9 Pyloric. 11 Right gastro epiploic. 17 Left gastro epiploic. 13 Cystic. 14 Splenic. 15 Pancreatic. 16 Vasa-brevia. 18 Superior mesenteric artery.

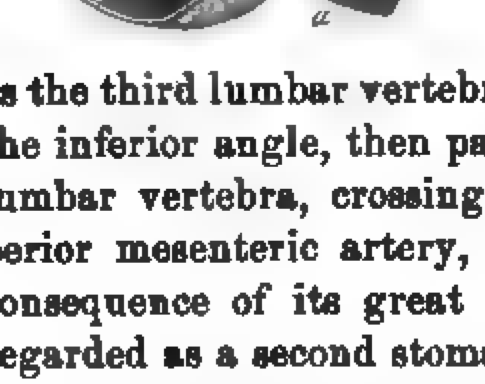
The small intestine reaches from the pylorus to the ilio-cœcal valve in the right iliac region. It is about an inch in diameter, is very much convoluted, and occupies principally the umbilical and hypogastric regions.

The large intestine is much greater in size than the small, though only about one fifth of its length, and extends from the right iliac region to the anus, occupying the most of the abdominal regions, and surrounding the small intestine like a ruffle. The whole of the intestinal canal has the same number of coats as the stomach; serous, muscular, cellular and mucous. There are some differences, however, in this canal, which we shall briefly notice under its respective divisions.

THE DUODENUM.

The duodenum, so called from being twelve fingers' breadth in length, is the shortest portion of the small intestine, though it has the greatest capacity. It is situated in the right hypochondriac, right lumbar, and portion of the umbilical regions. It takes a semicircular course. Commencing at the pylorus, it ascends to the under surface of the liver, then makes a turn called its superior angle, and descends vertically in front of the right kidney as low as the third lumbar vertebra, where it makes a second turn, the inferior angle, then passes to the left side of the second lumbar vertebra, crossing the spine, and beneath the superior mesenteric artery, terminates in the jejunum. In consequence of its great dilatation, it has by some been regarded as a second stomach.

Fig. 181.



The peritoneal coat of the duodenum furnishes a complete

Fig. 181 represents the Interior of Duodenum and a portion of the Stomach. *a a* Pyloric end of stomach. *b b* Folds and follicles of the mucous coat of the stomach. *c* Looks into the pylorus. *d* Thickness of pylorus. *e e* Rugæ of mucous coat of duodenum. *f* Point of entrance of the ductus communis choledochus.

covering only at the superior part, the inferior and transverse portions simply lying between the laminæ of the mesocolon, without any proper serous investment. By this arrangement the superior portion of the duodenum only is movable, the rest being fixed. In the circuit it makes, it encloses the head of the pancreas, and at the posterior part of its second curve, the *ductus communis choledochus*, or the common biliary and pancreatic duct, is seen to enter. This duct sometimes enters as two separate tubes, and passes in either case very obliquely through the coats of the duodenum.

The muscular coat has two sets of fibres; the one longitudinal, thinly scattered and superficial, the second internal, with its fibres arranged more closely together, so as to form a more perfect layer. They run circularly, though none surround the tube completely, forming only segments of circles. The muscular coat is rather pale and thin, though its color is deeper than that of any other portion of the small intestine.

The mucous coat presents on its surface a series of folds or processes termed *valvulæ conniventes*, which are permanent elevations of this membrane, and unlike the rugæ of the stomach, which are only accidental, are not effaced by distension. At the lower part of the duodenum they are large and numerous, while they are few in number and small at the upper portion. They represent a succession of arches or duplications of the mucous coat, nearly parallel to each other, running round the tube in almost, though not entirely perfect circles, about three lines in breadth, though generally wider in the middle; and having their extremities frequently bifurcated. These valvulæ greatly increase the extent of the absorbing surface of the chyle, and serve to retard the food in its downward passage, so that ample time shall be allowed for the extraction of all nutritious matter.

On the mucous coat are also seen numerous little processes resembling the down upon the cuticle of an unripe peach, and hence called *villi*. They are described as being

from one fourth to a line in length, and estimated by Meckel to be about four thousand to the square inch. These villi present, under the microscope, a foliated or fungiform appearance, covered by epithelium, and containing a minute plexus of blood-vessels, and a *lacteal tube*, all united by cellular tissue.

Fig. 182

The *lacteal* forms the prominent part of each villus. It commences, in the apex of the latter, by delicate branches, converging to a single trunk, which proceeds to the base of the villus, and there unites with similar tubes from other villi. It is not yet fully settled whether the lacteals begin by open orifices, or by anastomosing loops. The latter opinion is most strongly urged, though observations are not wanting to prove the existence of both arrangements. Those who deny that there are any open mouths, explain the absorption of the chyle, on the principle of *endosmosis*.

At the extremity of each villus, a mass of minute cells is described by Mr. Goodsir, as surrounding the loops of the lacteals. He regards them as true agents of absorption, first receiving the chyle, and, on becoming distended, transferring their contents, by solution or deliquescence, to the lacteals. It has been observed that, during digestion, these cells become erect and turgid with chyle, while in the interval they are found relaxed and empty, and present the appearance of a collection of granular germs. These cells are short-lived, being constantly destroyed, and as constantly renewed.

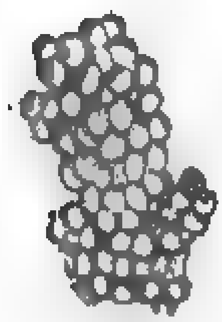
The mucous coat of the duodenum, besides the simple follicles of Lieberkuhn, scattered every where throughout the mucous tissue, contains also the *glands* of *Brunner*, (Fig. 183.)

These glands, situated in the sub-mucous tissue, surround this intestine in the form of a layer of white bodies of the size of hemp-seed, and of oval form. Each is said to contain several hundred follicles whose excretory ducts,

Fig. 182 represents a Villus and the commencement of a Lacteal.

like those of the sublingual gland, discharge separately

FIG. 183.



into the duodenum. The secretion of these glands is supposed to be like that of the pancreas or salivary glands.

The *arteries* of the duodenum come from the hepatic, splenic, and superior mesenteric. The *veins* go to the vena portæ. The *nerves* come from the solar plexus.

Function.—The duodenum completes the process of digestion, by changing the chyme, formed in the stomach, into *chyle*, and this by means of the bile and pancreatic juice poured into it from the liver and pancreas, through the common duct—the *ductus communis choledochus.*

The operation of the *bile* upon the chyme, is to separate it into three portions—one falls to the bottom, as a reddish brown sediment—another occupies the top, as a creamy pellicle, while the third remains in the centre, like fluid whey.

The action of the *pancreatic fluid*, about which there has been nothing but conjecture, seems to be pretty fairly determined by the recent experiments of M. Bernard, which go to show that this fluid decomposes, and holds in solution the fatty matters of the chyme, an effect, he asserts, which neither gastric juice, bile, saliva, nor any other agent can produce.* It is by the conjoint action of these two fluids upon the chyme, that another fluid, of the color and consistence of milk, is formed, called chyle, which is taken up by the lacteals of the villi, and introduced into the system.

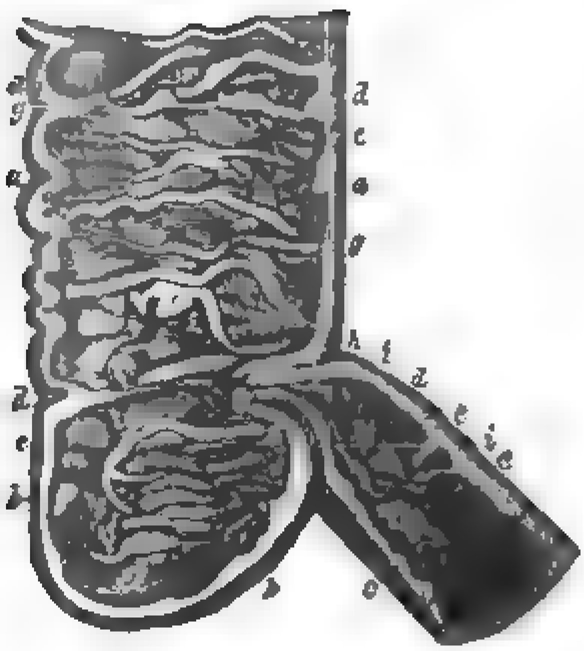
THE JEJUNUM AND ILIUM.

The jejunum, (*jejunus*, empty,) so called from being found frequently empty; and the ilium, (from εἰλεῖν, to twist,) are situated in the umbilical, hypogastric, and iliac regions. The jejunum commences in the left lumbar, and the ilium

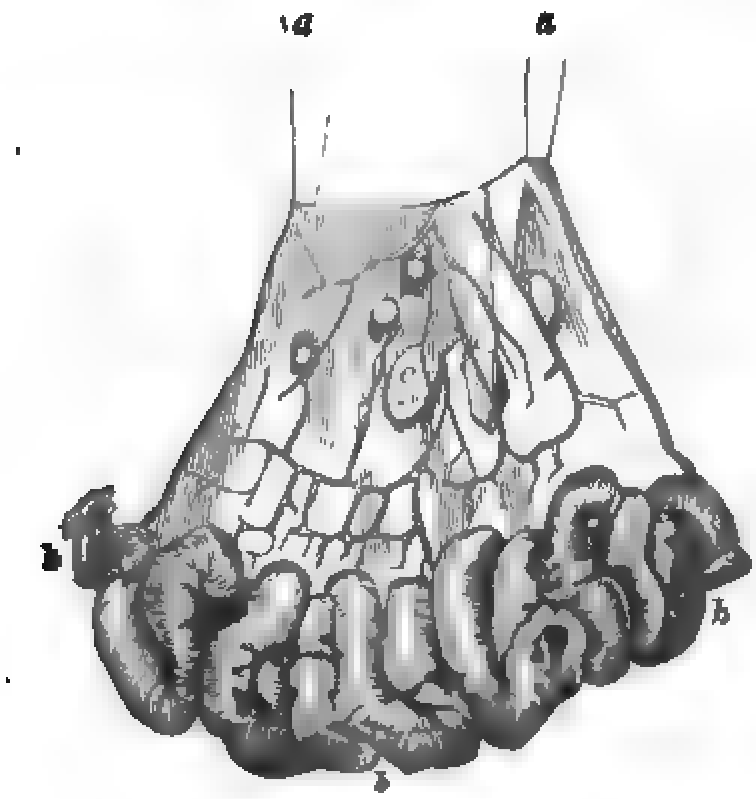
FIG. 183 represents one of the Glands of Brunner, as seen at the commencement of the duodenum—magnified a hundred times.

* See Ohio Medical and Surgical Journal, Vol. 1, No. 1, page 61, 1848.

FIG. 184. A.



B



ends in the right iliac region. There is no natural division showing where one of these intestines terminates, and the other begins. The upper two-fifths, however, are generally assigned to the jejunum, and the lower three-fifths to the ilium. These intestines are very much coiled on each other, and are convex in front, and concave behind, where they are attached to the mesentery.

The serous coat forms a complete covering to these intestines, except at the small triangular space where the blood-vessels enter; consequently there is freedom of motion, though both are kept in their natural places by their connection with the mesentery.

FIG. 184, A represents a section of the lower portion of the Ilium, and commencement of the Colon. *a a* Ascending colon. *b b* Cæcum, or caput coli. *c c* Lower portion of the ilium. *d d* Muscular coat. *e e* Cellular and mucous coats. *f f* Folds of mucous coat at the beginning of the colon. *g g* Cellular coat prolonged into the folds. *h h* Ilio-colic valve. *i i* Where the coats of the ilium and colon unite.

FIG. 184, B represents the Mesentery. *a a* Mesentery suspended. *b b b* Small intestine. *c* Mesenteric glands.

The mesentery (Fig. 184 B,) is a duplication of the peritoneum, having its root at the spine, about six inches in length, and extending obliquely from the second lumbar vertebra on the left, to the right iliac fossa. On the circumference of this reflection are placed the intestines, while between its laminæ are found the blood-vessels, nerves, lymphatic glands, and lacteals.

The muscular coat is not so strong as in the duodenum, though it is thought the two sets of fibres are more distinctly made out. They are pale and thin as in the duodenum. The longitudinal set shortens the tube, while the circular set constricts or lessens its diameter; the former producing the peristaltic, the latter the vermicular motion of the bowels. The conjoint action of the two carries on, step by step, the contents of this tube.

The mucous coat presents the valvulæ conniventes through the whole of the jejunum, more prominent than in the duodenum. These valves decrease as they descend, till in the lower part of the ilium for about two or three feet they are entirely absent. The mucous follicles are abundant and exist every where, as in the duodenum and stomach, presenting the usual cribriform appearance. The glands of Peyer seem peculiar to the ilium, and are chiefly found at its lower part and opposite the mesentery. They are seen in clusters called *glandulæ agminatæ*, (Fig. 25,) and present patches of small, white, circular raised spots, varying in size from a few lines to as many inches in length, and from eight to twelve lines in breadth.

These clusters are mostly elliptical in their shape, and as many as thirty of them have been recognized in the ilium, coming nearer and nearer to each other as they approach the termination of this intestine. The circular spots composing these clusters have few if any villi over their surface, but each one of them is observed to be surrounded by a circle of minute openings leading to the follicles of Lieberkuhn. There seems to be no connection between these follicles and the glands of Peyer, as the latter have no opening or excretory duct; but on being ruptured are

found to be cavities containing mucus and small cells in different stages of development.

Blood-vessels of Jejunum and Ilium.—The arteries come from the superior mesenteric. The veins go to the vena portæ. The nerves are from the solar plexus.

Function.—The absorption of chyle by the lacteals, originating in the various villi on the mucous surface of these intestines, seems to be their great duty. These villi becoming less and less numerous as we pass from the jejunum, the lacteals, and consequently the absorption of chyle, are found to diminish in like proportion.

THE LARGE INTESTINE.

The large intestine is from five to eight feet in length, and forms about one fifth of the intestinal canal. It is divided into the cœcum, colon, and rectum. It commences in the right iliac region where the ilium ends, and ascends through the right lumbar, to the right hypochondriac, then crosses the lower border of the epigastric and the upper edge of the umbilical to the left side, into the left hypochondriac region, whence it descends through the left lumbar and left iliac regions, to terminate in the rectum.

FIG. 185.

This intestine is seen thus to traverse all the abdominal regions, and to form nearly a complete circuit enclosing the small intestine. It has the same number of coats as the small bowel. The peritoneum

FIG. 185 represents the Large Intestine. *a* Termination of ilium. *b* Appendix vermiformis. *c* Caput coli or cœcum. *d* Transverse colon. *e* Descending colon. *f* Sigmoid flexure. *g h* Commencement and course of rectum. *i* Anus.

gives only a partial covering, and is studded all along the large intestine with little reflections containing fat, called *appendices epiploicæ.* In the ascending and descending colons, the peritoneal reflections are such as to receive the names of *right* and *left* mesocolon. The arch of the colon is almost entirely surrounded, has great facility of motion, and is kept in its place by the reflection termed *transverse mesocolon.* This reflection goes back to the spine and divides the abdominal cavity into two parts, thus separating the stomach, liver, and spleen above, from the intestines below. The rectum is kept in position by the reflection termed *meso-rectum.*

The muscular coat differs from that of the small intestine, in having its longitudinal fibres collected into three bands, which are equi-distant and about an inch in breadth; one of these bands is anterior, another internal, and the third external. These are white, strong, and elastic, and being shorter than the other coats, produce constrictions in its course, giving to this intestine a *cellular, sacculated,* or pouch-like appearance. These cells or pouches disappear when the bands are divided. These delay the too rapid passage of the fæces.

The mucous coat differs from that of the small intestine in being almost if not entirely destitute both of villi and valvulæ conniventes. The rugæ that are seen on its surface do not belong to the mucous coat alone, but are formed by the other coats. Each of the different divisions of this intestine has peculiarities requiring separate notice.

The *cæcum,* (Fig. 184; A) securely fastened in the right iliac fossa by the peritoneum, is from an inch to two inches in length, rounded below and convex externally.

From its posterior inferior portion on the left side, it gives off a tortuous process, called appendix vermiformis, about the size of a goose quill, and varying in length from three to six inches. Its position also varies. It has a peritoneal covering which allows it to float loosely, and it is sometimes the cause of much mischief by surrounding the ilium and producing strangulation. It is tubular,

having a diameter of two or three lines, is composed of similar structures with the rest of the intestine, and communicates with the cœcum by a somewhat valvular arrangement. The use of this appendix is unknown.

The cœcum is joined on its left side, at an acute angle, by the ilium. The ilium seems to perforate the cœcum, and at its point of entrance presents a transverse elliptical slit about an inch in length, (Fig. 184, A,) having accessory fibres called *retinacula*, to strengthen its extremities. The sides of this slit constitute folds or valves; the inferior or *ilio-cœcal*, and the superior or *ilio-colic* valve. The former prevents regurgitation from the cœcum, and the latter from the colon into the ilium. This valve consists of two layers of mucous tissue investing cellular and muscular fibres, and is formed by the mucous coat and circular fibres of the ilium protruding through a separation in the circular fibres of the cœcum. It looks downward.

The *colon* (Fig. 185) is a continuation of the cœcum upward, and is divided into the *ascending*, *transverse*, *descending*, and *sigmoid flexure*. Its course and connections have already, to some extent, been given; and it may be further added that the *ascending colon* passes in front of the right kidney, bordering the duodenum on the left, to the under surface of the liver, where, by its connection with the gall-bladder, it is frequently tinged with bile; thence it makes its arch (*transverse colon*) across the abdomen, being bounded above by the stomach, and below by the small intestine. On the left it descends, being hid by the small intestine in front, and resting upon the kidney, it terminates in the left iliac region by a curve which goes first upward, then by one or more coils downward, to the sacro-iliac symphysis, where it ends in the rectum. This curve is called the *sigmoid flexure*. It is covered by a reflection of the peritoneum, allowing it frequently to be quite loose, and giving it considerable motion.

The *rectum*, (Fig. 185,) so called from its straight course, is not so, strictly speaking, for commencing at the left ilio-sacral articulation, where the sigmoid flexure terminates,

it proceeds obliquely downward, in the pelvis, to the middle line of the sacrum, at the lower end of which, according to Mr. Harrison, it bends forward towards the perineum, then backward and downward, to end in the anus, about an inch or more from the coccyx. It presents, therefore, a curvature both in the lateral and antero-posterior directions. The course of this intestine, however, varies, and, in the fœtus, is almost invariably found straight, owing, doubtless, to the straight direction of the spine at that period.

The *size* of the rectum varies; small above, it expands below, just within the anus, into a wide pouch, which is not cylindrical, but flattened in front. In the male the rectum has the bladder, prostate gland, and vesiculæ seminales, on its anterior surface; while, in the female, on the same surface, are the vagina and uterus.

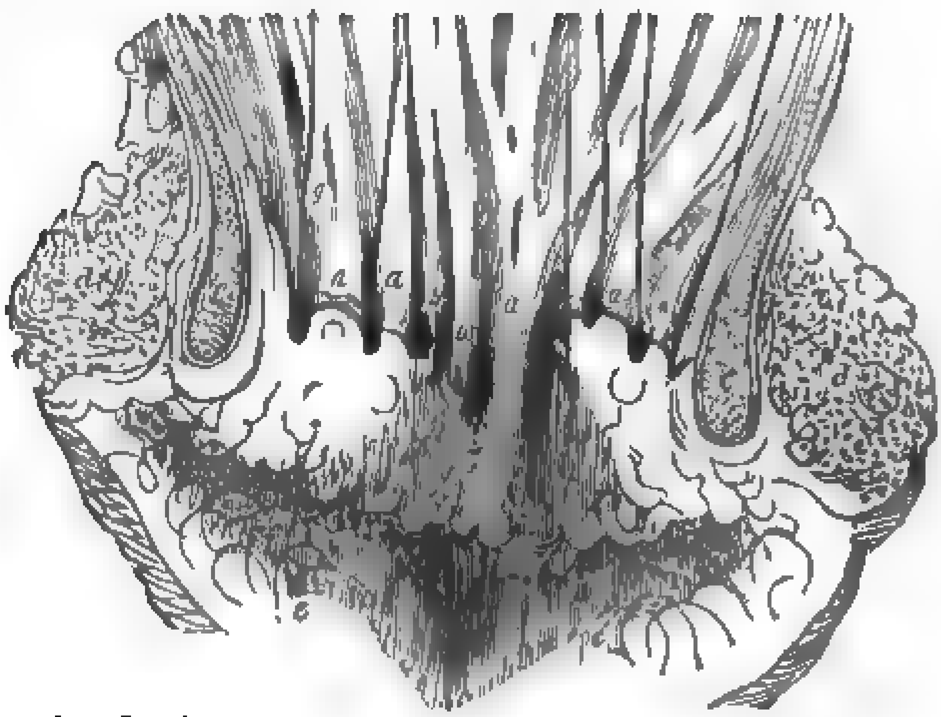
The peritoneum surrounds this intestine, only at its upper third, fixing it to the sacrum behind, by a reflection termed *meso-rectum.* In its middle there is only a partial covering in front and at the sides—while at its lower portion, or inferior third, it is entirely destitute of serous membrane, which is reflected from this point, upon the bladder in the male, and uterus in the female, forming, in each case, a pouch, or cul-de-sac, at the place of reflection.

The muscular coat of the rectum increases in thickness, and exceeds greatly that of any other portion of the intestinal canal. The longitudinal layer, which exists as bands in the colon, spreads out and multiplies, and forms a complete tunic for the rectum; and the circular layer also increases in strength and redness, in its descent, till, at the anus, its fibres become collected in a circular bundle, constituting the *internal sphincter ani muscle.* There are also some muscular fibres, surrounding the anus immediately beneath the integument, termed the *external* or *cutaneous sphincter.* Dr. Horner describes the longitudinal fibres, when they have reached the lower border of the internal sphincter, as turning under this border, between it and the external

sphincter, and then ascending for an inch or two, in connection with the mucous coat and its cellular structure, into which they are inserted. This arrangement explains the protrusion of the mucous coat in prolapsus ani.

The mucous coat is thick and red, presenting at the upper portion of the rectum rather a smooth surface, while at the lower are seen longitudinal folds called columns, which allow of the distension of this intestine, and also some transverse folds which are not regular as to number or

Fig. 186.



size. At the lower end of the columns, and between them, pouches are observed, (Fig. 186.) A radiated wrinkling is seen around the anus, which is formed by the contraction of the external sphincter. The margin of the anus is supplied with sebaceous follicles, and the whole mucous coat of the rectum abounds with mucous follicles.

The *arteries* of the large intestine are branches of the superior and inferior mesenteric, and of the internal pudic arteries. Its *veins* enter into the vena portæ. The solar and hypogastric plexus of the sympathetic supply it with nerves.

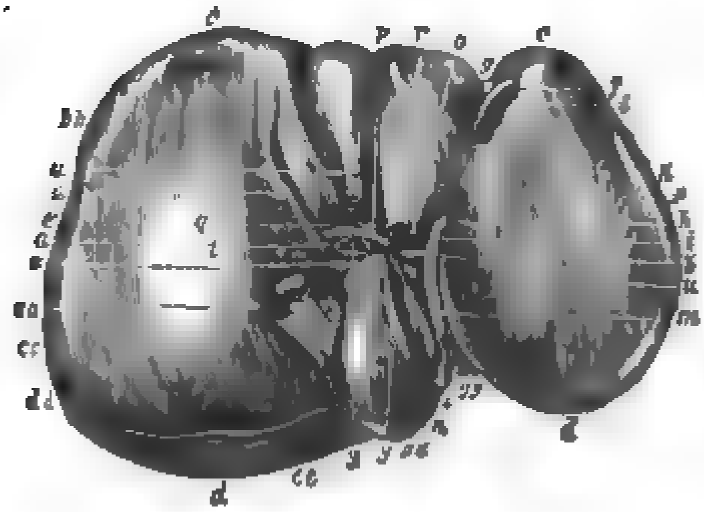
Fig. 186 represents a Section of the Anus and Rectum, showing the rectal pouches. *a a* Columns of the rectum. *b b* Rudiments of columns. *c* Internal sphincter divided. *d* External spincter divided. *e e* Folds of skin on the nates. *f* Pouches. *g* Bristles in the pouches.

Function.—To act as a reservoir for the fæcal matter, seems to be the principal use of the large intestine. But that it also possesses the power of absorption is proved by the fact of patients being sustained for weeks solely by injections of nutritious fluids into the rectum.

ASSISTANT ORGANS OF DIGESTION, OR COLLATITIOUS VISCERA.

The Liver, (hepar.)—The liver is justly regarded as one of the most important organs in the body, on account of the very extensive influence it exerts, both in health and disease.

FIG. 187.



It is *situated*, as already stated, in the right hypochondriac, extending across the anterior and upper portion of the epigastric, and occupying a portion also of the left hypochondriac region. Thus placed, it is of course below the diaphragm, to which it is attached by reflections of the peritoneum, termed ligaments.

These ligaments are five in number. The *falciform* or *suspensory* extends from the umbilicus, obliquely upward along the linea alba and the right side, to the diaphragm

FIG. 187 represents the inferior surface of the Liver. *a* Right lobe. *b* Left lobe. *c* Anterior thin margin. *d* Posterior thick margin. *e* Right extremity. *f* Left extremity. *g* Notch on anterior margin. *h* Longitudinal or umbilical fissure. *i* Round ligament. *j* Portion of suspensory ligament. *k* Pons or bridge across umbilical fissure. *l* Posterior extremity of longitudinal fissure. *m n* Where ductus venosus joins the inferior vena cava. *o* Transverse fissure. *p* Section of hepatic duct. *q* Hepatic artery. *r* Branches of latter. *s* Vena portarum. *t* Division into right and left sinus vena portarum. *u* Remains of ductus venosus. *v* Gall-bladder. *w* Its neck. *x* Lobulus quartus. *y* Lobulus spigelii. *z* Lobulus caudatus. *a a* Inferior vena-cava. *b b* Curve of liver. *c c* Depression for right kidney. *d d* Surface over renal capsule. *e e* Portion of liver uncovered by peritoneum. *f f* Coronary ligament. *g g* Depression for the vertical column.

with which it is connected by its convex border, while its lower or concave edge is fixed to the upper surface of the liver. Along the inferior margin, and enclosed within its fold, is a cord, called the *ligamentum teres;* this was formerly the umbilical vein of the fœtus, now obliterated and converted into a closed ligamentous cord. It passes into the anterior notch of the liver. The third and fourth ligaments are the *right* and *left lateral.* The former is reflected from the posterior part of the diaphragm to the posterior margin of the right lobe. The left lateral comes from the same part of the diaphragm and goes to the posterior margin of the left lobe. The *coronary* ligament is described as extending from the suspensory towards the lateral ligaments, and as consisting simply of the lateral extension of the former.

The liver lies in the concavity of the diaphragm, and is protected by the seven or eight inferior ribs. Below it is bounded by the stomach and duodenum, with which it is connected by the omentum minus; on the left is found the spleen, and behind are the ascending or inferior cava and vertebral column.

The *form* of the liver has been compared to an ovoid cut in the direction of its long axis. Its average length is from ten to twelve inches, and its width from six to seven inches. The weight is from three to five pounds, though all these measurements are liable to great variation. Its *color* is usually a reddish brown, not unfrequently interspersed with dark patches, especially on the lower surface, which however are not morbid. The color of the liver, indeed, varies as much as its weight and length. It is found red in the very young, and pale and yellow in the old. Its *consistence* is no less variable. It is generally firm, dense, and resisting, sometimes very hard and friable; then again quite soft, so much so as to break readily under pressure of the fingers. This latter condition is often owing to a fatty degeneration.

The *surfaces* of the liver are superior and inferior. The superior or upper surface is convex and smooth, fits in the concavity of the diaphragm, and is divided by the sus-

pensory ligament, from front to back, into two unequal portions.

The lower surface is very irregular, being marked by several eminences and depressions, or fissures. Running from the notch in the anterior edge of the liver backward, on a line corresponding with the direction of the suspensory ligament, is the *umbilical* or *horizontal* fissure, containing in its anterior portion the obliterated umbilical vein, and in its posterior the remains of the ductus venosus. This fissure divides the liver into its *right* and *left lobes*, and is sometimes converted at its anterior part into a complete tube, by a portion of the substance of the liver crossing it after the manner of a bridge and connecting its edges.

The *transverse fissure*, situated near the centre of the lower surface, is quite broad, about two inches in length, and crosses the umbilical at right angles. It contains the hepatic artery and duct, the vena portarum, lymphatics and nerves, and cellular tissue which bind all these together.

The *right lobe* is much the largest, and contains nearly the whole of the transverse fissure. Proceeding from it, behind the transverse fissure, and between it and the posterior part of the umbilical, is another lobe, called *lobulus Spigelii* or *middle lobe*. This lobe is somewhat pyramidal in its shape, and sends over the transverse fissure a projecting papilla, which is one of the *porta* or gateways of the liver. An elongation of the lobulus Spigelii, outward and forward along the right lobe and behind the transverse fissure, is called the *lobulus caudatus*. On the right lobe and in front of the transverse fissure, between the umbilical fissure and the gall bladder, is seen another elevation, not so distinct, called the *lobulus quartus* or *anonymus*. Its posterior extremity is opposite the Spigelian, and constitutes the second *porta* of the liver.*

* The author had an opportunity of witnessing a very curious *transposition of parts* on the inferior surface of a liver taken from a subject in the dissecting room of the Baltimore College of Dental Surgery. The following account was sent to the Medical Examiner, from which we quote: "I am sorry to say that I did not witness the removal of this liver, and did not see it in its natural situation, and cannot hence state, with positive certainty, which of the edges

Structure or different elements of the Liver.—This organ consists of membranes, blood-vessels, hepatic ducts, lymphatics, cellular tissue, nerves, and acini.

The membranes are the *serous*, which has been noticed, and the *fibrous*. This latter consists of condensed cellular structure, which lies beneath the serous coat, and forms the immediate covering to the whole surface of the liver, adhering to it, and sending innumerable processes every where into its substance, which both separate and surround the different granules or lobules, forming complete capsules for all the acini. This membrane also forms a sheath for all the vessels which enter or depart at the transverse fissure. This sheath follows and continues round the ramifications of these vessels throughout the liver, and takes the name of the *capsule* of *Glisson*. It is regarded in fact as the foundation structure of all the different elements composing this largest gland in the body.

The *blood-vessels* of the liver are of three kinds, two of these pass in, the other comes out. The *hepatic artery* and *vena portarum* enter the liver, while the *vena cava hepaticæ* pass out.

The *hepatic artery* is a branch of the cœliac axis, and as-

of the liver presented front and towards the ribs—a fact of some interest, and in reference to which I have to regret my not being able to procure any information from those who removed it.

"If where the umbilical vein or cord enters, be taken as the anterior edge of the liver, in accordance with the usual anatomical descriptions, then the state of things is as follows:

"1. The thickest edge, with its round and smooth surface, which is always described as posterior, is now found in front, while the anterior sharp edge is placed behind. 2. The right lobe is much the smallest, and about the size of what the left usually is, while the left was the usual size of the right. 3. The lobulus Spigelii is in front, instead of behind the transverse fissure, and on the left, instead of the right lobe. 4. The inferior vena cava was also in front of the liver, instead of its back part, and on the left instead of the right lobe. If, on the other hand, the thick and round edge of the liver, together with the usual situation of the lobulus Spigelii and ascending cava, be taken as the posterior edge, then the situation of the parts is as follows: 1. The gall bladder is on the posterior edge of the left lobe, instead of the anterior and inferior surface of the right. 2. The umbilical cord enters the centre of the posterior edge, instead of the fissure on the anterior edge. 3. The lobulus Spigelii passes over the transverse fissure to the left lobe."

This duct is to the right of the artery, having the vena portæ behind and between the two. It has two coats—the internal is mucous, and the external fibrous. The use of the biliary ducts is to convey the bile, after its secretion in the liver, to either the duodenum or the gall bladder.

The *lymphatics* are numerous and arranged into a superficial and deep set. The former are seen beneath the peritoneum, in the form of a net-work. The latter pass out of the liver, at its transverse fissure, and go to the adjacent lymphatic glands, or enter the thoracic duct.

The *nerves* come from the solar plexus, and accompany the blood-vessels into the liver. Some filaments are traced from the pneumogastric and phrenic.

The Acini.—This element is best seen by tearing the liver, when it presents the form of granules, about the size of millet seed, which, from their resemblance to the seed of the grape, were called, by Malpighi, *acini*. Their shape is described as spheroidal, or polyhedral, and each one is considered a perfect miniature of the entire gland, as each is composed of the capillary blood-vessels of the liver, with commencing radicles of the excretory ducts or pori biliarii.

MICROSCOPIC ANATOMY OF THE LIVER.

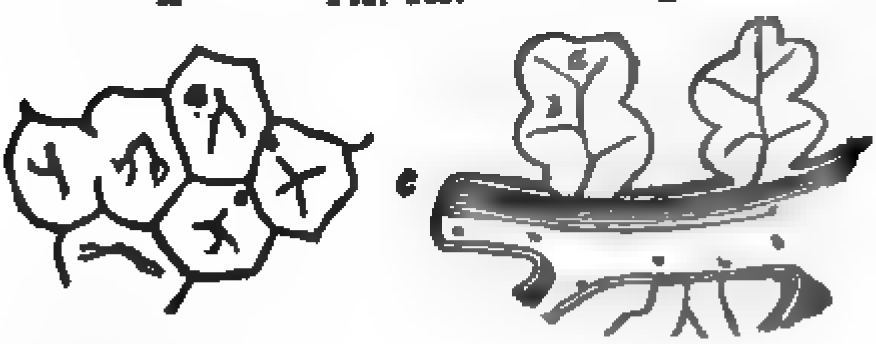
The observations of Mr. Kiernan are generally received as the most accurate, though their entire correctness has been called in question by some of the most respectable anatomists. According to this gentleman, the acini of Malpighi should be called *lobules*, as they contain still smaller granules, which he calls the proper acini, and which present two colors—a brown and a yellow, termed the cortical and medullary portions.

This distinction, however, is now pretty generally abandoned, the structures being regarded the same, and the difference in colors being considered as due to the higher vascularity of the brown, and the presence of bile in the origins of the pori biliarii of the yellow.

The lobules present a rounded form with angular projections. Each has a base which rests upon a hepatic vein,

the *sub-lobular*, (Fig 189, B.) The base enters into the constitution of the walls of the sub-lobular vein, and the remainder of the lobule has its surface covered with the capsule of Glisson, in which the minute branches of the venæ portæ, hepatic vein, and hepatic duct ramify.

A Fig. 189. B



The interior of the lobule has its centre (Fig. 189, A) occupied by a vein, called *intra-lobular*, which connects it with the sub-lobular *vein*. The intervals, between the fissures of adjacent lobules, are called *interlobular fissures;* and the spaces, formed by the apposition of several lobules, are called *interlobular spaces*. These spaces and fissures are, occupied by the delicate branches of the portal vein, hepatic artery and duct, termed each *interlobular*, and formed from the plexuses belonging to the sheaths, constituting the portal canals, which are hence called *vaginal plexuses*. From the interlobular, branches of each set proceed, and enter the lobules, forming plexuses in each, called *lobular venous*, and *lobular biliary plexuses*.

The lobular plexus of the portal vein contains, in its meshes, the acini, or biliary plexus, and is traced into the intra-lobular vein, and thence to the sub-lobular, from which the hepatic veins are formed. It is not settled whether the terminations of the biliary ducts are cœcal, or anastomosing arches.

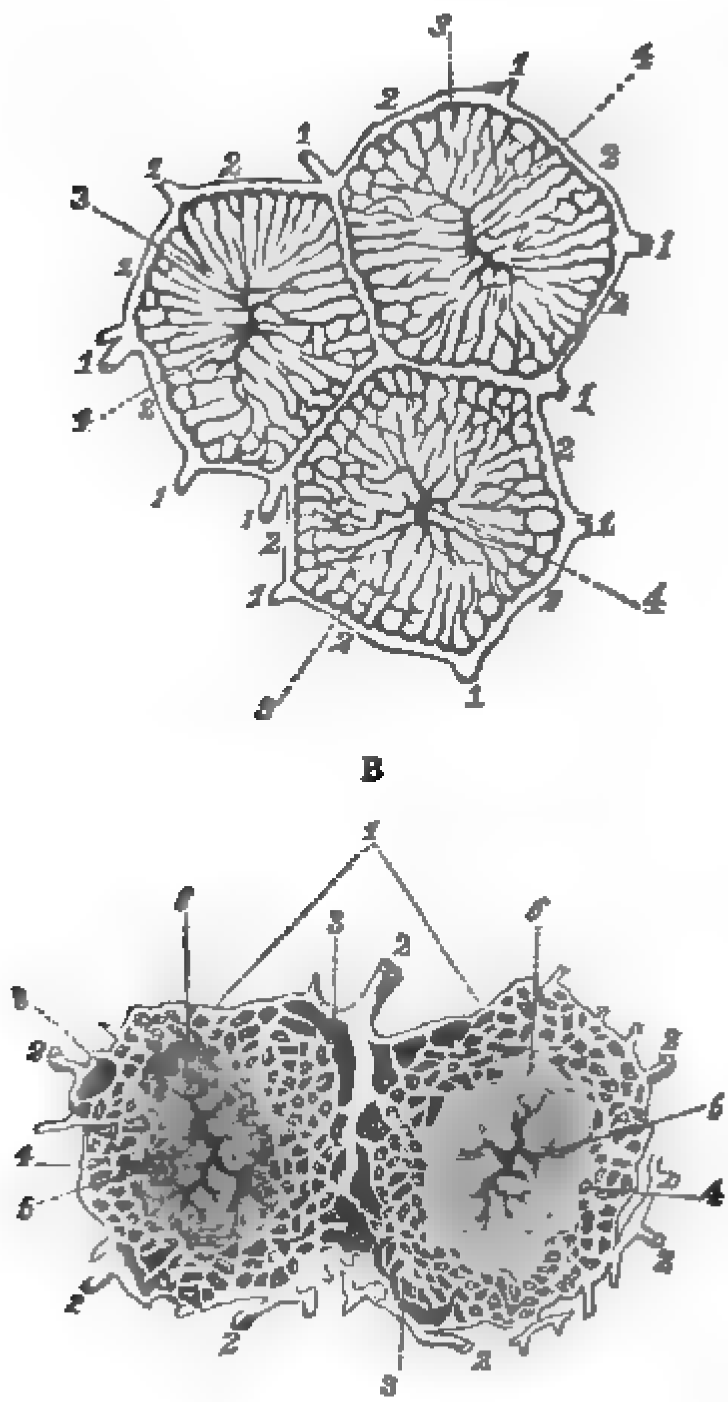
The lobules, thus constituted, are supposed to be nothing but a congeries of biliary ducts, surrounded by blood-vessels. More recent observations, with the microscope, make each acinus to consist of a collection of cells of various size

Fig. 189, A represents the Lobules of Mr. Kiernan. *a* Intra-lobular vein. *b* Interlobular fissure. *c* Interlobular space.

Fig. 189, B represents the Sub-lobular vein. *a* Lobule. *b* Intra-lobular vein. *c* Sub-lobular hepatic vein—a longitudinal section being made of it.

and shape, containing bile with globules of fat; thus proving, it is thought, that these cells are the real secreting agents of the bile, and that from these cells it is conveyed into the pori biliarii by a process not yet settled. The liver is developed by a protrusion from the intestinal canal.

Fig. 190. A



The *gall-bladder* (Fig. 187) is *situated* in a depression upon the anterior part of the lower surface of the right lobe of the liver, and is a reservoir for receiving the bile. Its form is conical; its larger portion, or *fundus*, projects somewhat beyond the anterior edge of the liver, and looks to the right, downward and forward. Its narrow or constricted portion, called the *neck*, is directed upward and back-

Fig. 190, A represents a horizontal section of three Lobules, displaying the two principal systems of Blood-vessels. 1 1 1 Interlobular veins in the spaces. 2 2 2 Interlobular veins in the fissures. 3 3 3 Lobular venous plexus. 4 4 4 Intralobular branches of hepatic veins.

Fig. 190, B represents the Lobular Biliary Plexus. 1 Two lobules. 2 2 2 Interlobular ducts. 3 3 3 Interlobular cellular tissue. 4 4 Lobular biliary plexus injected. 5 5 Intra-lobular branches of hepatic vein. 6 6 Central portions of lobules uninjected.

ward to the left, where it becomes somewhat convoluted, and ends in a tube, called the *cystic duct*, about an inch and a half long, which has already been described as joining the hepatic, to form the *ductus communis choledochus*, whose entrance into the duodenum has already been traced.

The gall-bladder has three coats. The first, or *peritoneal*, is partial, covering only the anterior surface; the second consists of condensed cellular structure, and is called the *fibrous;* while the third, which is internal, is the *mucous coat*. This coat presents wrinkles or folds which take a tortuous or spiral course, and have between them numerous cells, which give the surface of this coat a honeycomb appearance. This coat is always found colored, either yellow or green, from the bile.

Blood-vessels.—The artery of the gall-bladder, the *cystic*, comes from the hepatic. Its *vein* goes to the vena portæ. Its *nerves* come from the sympathetic. Its *lymphatics* are numerous, and unite with those of the liver. The gall-bladder is developed by an offset from the hepatic duct.

Function of the Liver.—The office of this viscus is clearly to secrete the bile, which secretion is found to occur in the lobules or acini, from the blood of the portal vein.

The bile is a viscid fluid, of a yellow or greenish yellow color, and a very bitter taste. It is said to consist of *cholesterine*, which is a white, fatty, crystallizable substance, resembling spermaceti; *choleic acid*, which is a peculiar animal substance combined with soda; and coloring matter called *biliverdin*. The chemical analysis of Berzelius makes bile to consist of *water*, 80 parts; *bilin*, a substance taking the resinous condition by the application of an acid, 8 parts; *mucus*, 3 parts; *saline* substances, of which soda is the prominent, 9 parts.

The offices of the bile are, first, to act upon the chyme in the duodenum, in its conversion into chyle; second, a portion of it unites with the residuum of the chyle, and is passed off by the bowels as excrement, thus ridding the blood of its superfluous hydro-carbon; third, it excites the peristaltic action of the muscular coat, and acts as a stimulus to

increased secretion from the mucous follicles; and fourth, the liver is regarded as the only organ for depurating the blood of its superfluous hydro-carbon, in the fœtal state or before respiration is established.*

THE PANCREAS, (πας χρεας, all flesh.)

This gland is next in importance to the liver, from the assistance it renders in completing the digestive process, the formation of the chyle.

It is *situated* in the posterior epigastric region, behind the stomach, and in front of the spine, the lesser muscle of the diaphragm, the aorta, ascending vena cava, and superior mesenteric artery, and between the two laminæ of the mesocolon. Its *direction* is across the body, transversely from the spleen on the left, with which it is connected, to the curvature of the duode-

Fig. 191.

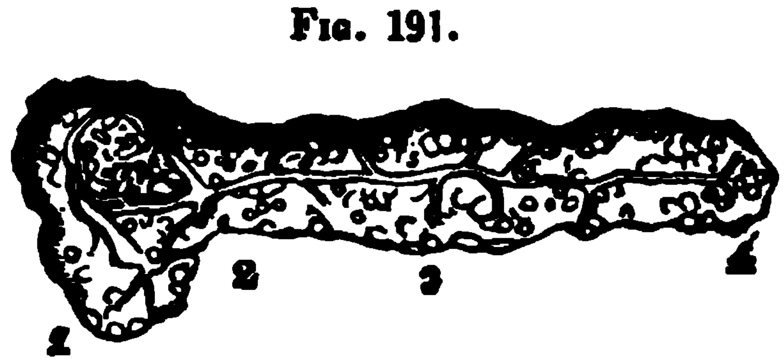


Fig. 191 represents the Pancreas. 1 Head of the pancreas. 2 Neck. 3 Body. 4 Tail. 5 Pancreatic duct.

* In addition to these functions, M. Bernard adds those of "*sanguification* and *equilibrium*." His recent experiments seem to show that the Liver forms sugar, fibrin, and fat; that these three substances contribute to establish the equilibrium in the blood, and that no matter what the aliment is, the liver has the power to transform it into material fit for nutrition. Thus the composition of the blood is preserved in its proportionate number of regular, healthy elements; for the sugar, fibrin, and fat, being thus furnished, restore to the blood again those substances which it is continually losing, and thus preserve the blood in a state of health. In a chemical point of view, the liver is considered an organ of *sanguification*.

But the liver is also regarded as regulating the *equilibrium* of the circulation. Thus, in carniverous animals there is less fat secreted by this organ, because there is more taken, already formed, as aliment. In the herbiverous class, where there is much saccharine matter consumed, the liver forms less sugar; and the less fibrin the stomach digests, the more it is found the liver contains. Consequently in man, whose diet is so variable, the blood will be furnished, by the liver, with that element in the largest proportion, which is found most deficient in his aliment, thus making this organ a balancing organ, or organ of *equilibrium*. From American Journal Medical Sciences, October, 1851.

num on the right, (Fig. 180,) where it is closely attached, and from which it is often with difficulty separated. Its *form* is somewhat of a parallelogram, about seven inches in length, and two in breadth. Its *color* is of a light gray, or pink. Its *structure* resembles that of the salivary glands, so much so that it is called the abdominal salivary gland. It belongs to the conglomerate class of glands, and consists of lobules of various size, which are resolvable into still smaller bodies or granules, all of which are connected by cellular tissue, with their interstices occupied by blood-vessels. This gland has no proper peritoneal coat, nor investing tunic, unless the lamina of condensed cellular membrane which surrounds it, be considered as such.

Its *arteries* come from the *splenic*, which courses the upper margin. Its veins enter the splenic, and thence the vena portæ. Its *nerves* are from the solar plexus.

Its *excretory duct*, called the *ductus Wirsungii*, is seen by scraping off some of the surface of the gland about its centre, and is traced as a remarkably white and thin tube, extending from the left extremity or tail of the gland, to its right or head. Here it increases in size, and is sometimes joined by a duct from the lesser pancreas, which is only an enlargement of the head. This duct, just before entering the duodenum, joins the ductus communis, though it is not unfrequently seen to enter separately. It arises by fine radicles from the granular masses, constituting the lobules, like the vesicular origins of the salivary glands. These unite to form the still larger tubes which proceed from the circumference to the centre, and discharge nearly at right angles into the common duct.

Function.—To secrete the pancreatic fluid, which, as stated elsewhere, is conveyed into the duodenum; with the bile, by their combined agency, it converts the chyme into chyle. But what part this fluid takes, or what is its special action in the process of chylification, all works on anatomy and physiology tell us is yet unknown. This uncertainty or obscurity as to the use of the pancreatic fluid, would seem to be entirely removed, and the question conclusively

settled, by the recent experiments of M. Bernard.* The following is given by Prof. March as the substance of those experiments, at which he was present: "Pancreatic juice, when collected from a living animal (a dog for example) by means of a fistula artificially established, has clearly identically the same physical character as the saliva, being limpid, colorless, slightly ropy, and rather heavier than water. It is constantly alkaline, and is coagulable by heat and strong acids, owing to the presence of albumen. The saliva is slightly alkaline when collected pure, but never coagulable by heat or acids. When the pancreatic juice is put in contact with azotised aliments, as fibrin, albumen, and gelatine, there is no effect produced. Putrefaction occurs in time, but no digestion. When applied to farinaceous substances, they are changed into sugar, which is absorbable." Thus far, he states, is known. But it was not known before the discovery of M. Bernard, "that when this fluid, the pancreatic, is put in contact with fatty substances of every nature, as oils, animal fats, butter, &c., they are quickly *digested* or *decomposed*, and reduced to a state in which they may be absorbed into the circulation. This property is peculiar to the pancreatic juice, not being possessed by the saliva, gastric juice, bile, serum, nor any other fluid of the animal economy. The first effect produced when you put the pancreatic fluid in contact with the oil, or any fatty substance, is to form an intimate emulsion, which will not separate on standing. If you agitate oil with saliva, gastric juice, serum or pure bile, or any other animal fluid, the mixture separates when in repose."†

The great office of the pancreatic fluid then, in changing the chyme into chyle, seems to be to dissolve and hold in solution its fatty matters, that they may be capable of absorption. M. Bernard also states, as an established fact,

* The facts stated above are taken from the first number, Vol. 1st, of the "Ohio Medical and Surgical Journal," for September, 1848.

† Frerichs contradicts Bernard's statements on this point, but he has manifestly misunderstood them. The result of the experiments made by him, Bidder, Schmidt and Lenz, has been rather a modification than a refutation of his views. For a brief account of these results, see "Dental Chemistry," p. 144.

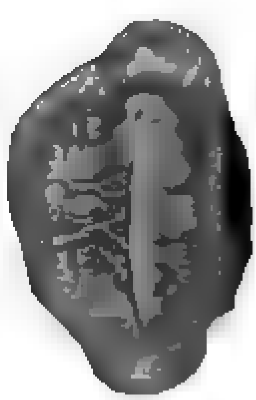
"that the union of the bile and pancreatic fluid produces a new and distinct fluid, having, in addition to the peculiar properties of these two fluids, another superadded, that of digesting azotised substances, or, in other words, having the properties of the gastric juice."

THE SPLEEN, (σπλήν, lien.)

The spleen (Fig. 180) is *situated* in the posterior part of the left hypochondriac region, having the diaphragm above, and the colon and kidney below, and the stomach and pancreas upon its right. Its shape resembles an oval, cut in the long direction. Its *color* varies, though most generally it is a deep blue or purple. Its *size* also varies, being from four to five inches long, and from two to three inches wide. It is convex towards the ribs, and concave towards the stomach. In this concavity there is a depression called *hilum lienis*, in which the blood-vessels and nerves enter and pass out. Sometimes there are several spleens, in which case the superfluous ones are said to be not larger than nutmegs.

Structure.—This organ (Fig. 192) has two coats, *serous* and *fibrous*. The serous is a reflection from the peritoneum, and gives it a complete investment, except where the vessels enter. This coat attaches the spleen to several organs, as the stomach, colon, and diaphragm, by its reflections, called *gastro-splenic*, *splenico-colic*, and *splenico-phrenic* ligaments.

FIG. 192.



The fibrous or proper coat is closely connected with the serous, and is a thin, but compact, extensible, and elastic membrane, which not only surrounds this organ, but sends down into its substance innumerable fibres and lamellæ, which traverse it in every direction, and divide it into partitions, making it cellular. This coat also forms sheaths for the blood-

FIG. 192 represents the Spleen. Between 1 and 2, hilus or fissure of the spleen, where the blood-vessels enter and pass out. 4 One of the larger branches of the splenic artery. 5 Splenic vein.

vessels in their distribution through this organ. The cells are filled with a bloody pulp, of a grumous character, in which the microscope detects a number of small oval corpuscles, of a reddish color, and about the size of the red globules of blood. The spleen contains also some small bodies, called after Malpighi, which are described as being about the third of a line in diameter, and consisting of convoluted blood-vessels and lymphatics, connected by elastic tissue, and resembling minute lymphatic glands. They are said to contain lymph of the color of milk.

Blood-vessels.—The *splenic artery*, the largest branch of the cœliac, takes a tortuous course along the superior margin of the pancreas, and enters the *hilum* of the spleen by five or six branches, which ramify minutely throughout its substance. Injections have shown that the different branches do not anastomose, hence each branch is regarded as having an independent function, and the spleen as consisting really of several organs like the conglomerate glands. The *veins* are numerous, having thin coats, and presenting enlargements, which are compared to the corpus cavernosum penis. These differ from the arteries by anastomosing freely with each other, and unite to form the *splenic vein*, a very large trunk, which is one of the principal roots of the vena portæ. This vein, like the rest of the portal veins, is without valves.

The *nerves* come from the solar plexus and accompany the artery. The *lymphatics* are superficial and deep, and go to glands at the hilum.

Function.—The use of this organ is unknown, but, notwithstanding this, there is no scarcity of speculations about the matter. The most generally received theory is, that it serves as a reservoir or *diverticulum*, when the abdominal organs are threatened by undue congestion of the portal system.

SECTION III.

ORGANS OF ABSORPTION OF THE TRUNK.

The organs of absorption naturally follow, in the physiological arrangement, those of digestion; for while it is

the office of the latter to convert the crude aliment into chyme and chyle, it is the business of a portion of the former to take up this chyle, thus prepared for the nutrition of the body, and introduce it into the circulation, whence it is conducted, along with the blood, to the lungs, where it receives its final and finishing stroke as blood, to be now taken up, by the organs of circulation, and distributed throughout the system for the support of every part.

The organs of absorption comprise three sets of structures—the *lacteals*, *lymphatics*, and *lymphatic* or *absorbent glands*.

Under the head of glandular tissue, some general remarks are made upon the absorbent system. The lacteals (Fig. 182) and lymphatics are regarded as parts essentially of the same system of vessels, though having different names. The structure of both is the same, consisting each of two coats—an *external*, which is regarded as fibrous by some, and muscular by others; and an *internal*, which is very delicate and transparent, resembling that of the veins. A middle coat is also spoken of, which is thin, as in the veins, but destitute of the elastic lamina. Like the veins, the internal coat of the absorbents presents numerous folds constituting valves. These valves are of semilunar shape, and arranged in pairs, giving the vessels containing them a braided or knotted appearance, (Fig. 18.) These valves prevent the retrograding of the chyle and lymph. The absorbents, like the veins, are divided into the superficial and deep, and have their fluids running the same direction.

The trunks of the absorbents terminate in the venous system; hence these two are only regarded by some as continuations of one and the same system. This difference however is observed, that all the absorbents, whether superficial or deep, converge and pass through a set of bodies called *lymphatic* or *absorbent glands*, while veins do not. The absorbents, on entering these glands, are termed *vasa inferentia*, and on passing out *vasa efferentia*. These glands, as elsewhere stated, are very numerous, presenting a reddish, or gray color, varying in size from a cur-

grant to an almond, and mostly of an oval or round form. Their consistence is firm, each being surrounded with a fibrous capsule. They generally run in chains or clusters.

The division of the absorbents into lacteals and lymphatics, is founded on the color of the respective fluids; the chyle of the lacteals resembling milk, while the lymph of the absorbents looks like serum or water.

The lacteals are limited to the abdomen, and have their origin in the numerous villi of the small intestine, especially its upper portion, which converge to the mesenteric glands, through which they pass, and thence proceed, after being reduced to one or more trunks, along the superior mesenteric artery to its root, where they enter the thoracic duct. The mesenteric glands are situated between the laminæ of the mesentery, and are estimated at about one or two hundred in number.

The *lymphatics* are found in every part of the body, except the interior of the brain, spinal cord, cartilages, tendons, and ligaments, and though they are not as yet demonstrable in these parts, there is, nevertheless, the strongest reason, from analogy, for believing that they exist there. Their *function* is to absorb from every tissue all the particles of matter that have become effete, useless, and as it were, worn out, and to conduct these into the thoracic duct, there to mingle with the chyle from the lacteals, and thence into the circulation, or as in the right head and neck, and right upper extremity, to go more directly into the venous system. The *lymph* then, like the chyle, is carried into the venous circulation, is mingled with the venous blood, and conducted to the lungs, where the purification and conversion into arterial blood occurs, so that it is fitted to enter the system, and perform the same office of nutrition as before.

THE LYMPHATICS AND GLANDS OF THE STOMACH.

The lymphatics of the stomach are superficial and deep. The former present a plexiform arrangement beneath the peritoneum; the latter, a similar appearance in the mucous

coat, converging from different directions, thus accompany the epiploic and coronary vessels to the glands, along the greater and lesser curvature of the stomach, amounting to eight or ten in number, through which they pass, and thence proceed to the thoracic duct. Some are seen going to the glands of the spleen, and others to those about the pylorus.

LYMPHATICS AND GLANDS OF THE INTESTINES.

The lymphatics of the small intestine, like those of the stomach, are *superficial* and *deep*, the former being situated beneath the peritoneum, the deep in the mucous coat, or between the latter and the muscular. Both sets enter the mesenteric glands, and go, as stated, to the thoracic duct.

The *lymphatics* of the large intestine are not so numerous as those of the small. They have a like division into superficial and deep, and also follow the course of the blood-vessels. Those of the ascending and transverse colon unite with the lymphatics of the mesentery; while those of the descending colon and sigmoid flexure enter the lumbar glands. The lymphatics of the rectum do not all go to the lumbar glands—part of them enter the hypogastric. The *lumbar glands* are very numerous, and found along the course of the common iliac arteries, continuous with the pelvic chain, also around the aorta, ascending cava, on each side of the bodies of the lumbar vertebræ, and, in fact, scattered in every direction from the base of the sacrum to the diaphragm. These glands not only give passage to the lymphatics of the left portion of the large intestine, but they also receive all those of the pelvis, corresponding to its several viscera, which, after passing through the iliac, sacral, and lumbar glands, finally enter the receptaculum chyli, by several large trunks which form the commencement of the thoracic duct.

LYMPHATICS AND GLANDS OF THE LIVER.

The lymphatic vessels of the liver are superficial and deep, and exceedingly numerous. They are readily in-

jected from any of the large trunks, by the yielding of the valves. The superficial set are found all over the convex and concave surfaces of the liver, pursuing different directions. On the convex surface some are seen to enter the suspensory ligament and pass through the diaphragm to the glands in the anterior mediastinum; others go to the horizontal, thence to the transverse fissure, and on to the glands of the omentum minus and pylorus; while others are seen to accompany the vena cava into the chest, and enter the thoracic duct. On the concave surface of the liver they are equally numerous, some passing to the lesser omentum, and others to the superior lumbar and inferior intercostal glands. A distinct plexus is seen around the gall-bladder.

The deep lymphatics of the liver take the course of the portal vessels and biliary ducts, and pass to the glands of the lesser omentum, and thence back to the spine to enter the thoracic duct. The lymphatic glands of the liver are found along the hepatic vessels, and continuous with those on the cœliac artery.

The *Lymphatics* of the *Pancreas* and *Spleen* pass to the glands along the splenic artery, and finally terminate in the thoracic duct.

The *lymphatics* of the abdominal parietes follow the course of the epigastric, ilio-lumbar, circumflexa ilii, and lumbar arteries, and go to the iliac and lumbar glands. Those of the diaphragm join the intercostal and internal mammary.

THE LYMPHATICS AND GLANDS OF THE CHEST.

The lymphatics of the chest are divided into the *parietal* and *visceral*. The former pursue the course of the thoracic, internal mammary, and intercostal vessels, and go to the axillary, inferior cervical, and intercostal glands.

The visceral lymphatics belong to the lungs, the heart, and thymus gland.

Those of the lungs are superficial and deep. The former are spread as a net-work over the pulmonary surface beneath the pleura, and proceed to the root of the lungs to

enter the bronchial glands. The deep-seated take the course of the bronchial vessels and tubes, and also go to the bronchial glands, and the thoracic duct, and some to the right lymphatic duct at the base of the neck.

The *lymphatics* of the *heart* accompany the coronary vessels and proceed to the bronchial glands, and thence to the left thoracic duct.

The lymphatics of the thymus gland, go to the bronchial glands; and those of the œsophagus, which are found to be very numerous, so much so as to form a continued plexus around its whole extent, also enter the bronchial glands.

The *lymphatic glands* of the chest are also parietal and visceral. The former are found near the heads of the ribs, between the intercostal spaces, posterior to the sternum, along the internal mammary vessels, a few in the anterior mediastinum reaching from the diaphragm to the neck, and a chain of them along the œsophagus and aorta in the posterior mediastinum.

The visceral glands are the *bronchial* or *pulmonary*, which are situated about the root of the trachea at its division, and pursue the course of the bronchia for some distance into the structure of the lungs. They are numerous and large, and are estimated at from ten to twenty in number. Their most striking peculiarity is their color, which is black, and is stated to depend upon a deposition of carbon from the bronchial lymphatic vessels. In early life these glands are of a reddish color, then gray, and finally black.

The *left or great thoracic duct*, which is the common tube for the lymphatics of all the viscera and structures below the diaphragm, as well as those of the left side of the chest, left neck, head, and left upper extremity, commences below the diaphragm in the receptaculum chyli, passes up the chest between the aorta and vena azygos, and finally terminates at the junction of the left subclavian and internal jugular veins. Its course is more fully described under the head of glandular tissue.

The *right lymphatic duct* receives the lymphatics of the right side of the chest, right lung, right diaphragm, right upper extremity, right neck, and head, is about an inch in length, and enters the angle formed by the junction of the right subclavian and internal jugular veins.

This is the most common disposition of the two thoracic ducts, but there occasionally occur varieties in their origin, course, and termination.

CHAPTER IV.

THE ORGANS OF THE TRUNK.

THIRD DIVISION.

ORGANS OF THE CHEST.

In the physiological order these organs are divided into the organs of *respiration*, and the organs of *circulation*.

GENERAL OBSERVATIONS ON THE CHEST.

The cavity of the chest or thorax occupies an intermediate *situation* and *size*, in comparison with the other two great cavities of the trunk, the cranial and abdominal, and intermediate also in relation to the structure of its walls; for while those of the abdomen consist in great measure of soft parts, and those of the head of a hard and complete bony case, the walls of the thorax, on the other hand, combine the properties of both, in consisting of hard and soft parts in nearly equal proportions, and thus harmoniously blending the fixed and dilatable conditions of each.

Some general remarks have already been made under the head of passive organs of the trunk, where it was stated that the thoracic cavity presented the form of a truncated cone, with the apex above and base below, flattened before and behind, and convex at the sides; that its form and diameters are liable to variation both from disease and

mechanical appliances, and that its appearance is very different when viewed after having the upper extremities detached. In this condition, with the arms removed, the chest looks larger, as it really is, below than above, while in the living state, or with the bony shoulder and arms appended to the skeleton, this cavity looks larger above than below, which it is not. The chest is bounded, as stated, by the sternum and costal cartilages in front, by the dorsal vertebræ behind, the diaphragm below, the ribs and the intercostal muscles laterally, and the superior opening of this cavity, which is occupied by the passage through it of the trachea, œsophagus, muscles, vessels, nerves, and cellular tissue, above. It is also lined by a serous membrane, which is reflected from its interior walls over the lungs and pericardium, called the *pleura*. All these parts have been described elsewhere, except the muscles on the anterior walls of the chest and pleura, which we shall now proceed to notice.

SECTION I.

MUSCLES OF THE CHEST.

Dissection.—Make an incision through the integuments from the upper edge of the sternum along the median line to the xiphoid cartilage. From the upper end of this incision carry a second along the clavicle to the acromion process, and from its lower end a third along the lower margin of the great pectoral muscle, which is readily seen, to the humerus. Raise the integuments by commencing the dissection along and in the direction of the third incision for the right side, and from the second incision for the left side. This will be exposing the great pectoral muscle in the direction of its fibres. A superficial fascia will be raised at the same time with the integuments, which is both delicate and cellular, and continuous above with the superficial fascia upon the neck, and below with the same upon the abdomen.

The *Pectoralis Major* (Fig. 167) arises fleshy from th anterior two-thirds of the clavicle, tendinous from the an-

terior surface of the sternum, the whole length of its two upper bones, meeting its fellow tendon of the opposite side along the median line, where they decussate, and thus cover the sternum with a kind of aponeurosis. We have, however, several times seen the sternal origin of this muscle entirely fleshy, and meeting its fellow in the same way along the median line. It also has a fleshy origin from the fifth and sixth ribs, sometimes also from the third and fourth, and a slip, sometimes fleshy and sometimes aponeurotic, is seen to connect the lower portion of the costal portion with the upper tendon of the external oblique or rectus muscle. From these several origins the fibres pursue different directions, the clavicular descend, the sternal run horizontally, and the costal ascend—the whole uniting into one broad, thin tendon, which is *inserted* into the anterior edge of the bicipital groove. At the axilla the muscle is folded inward, presenting a thick, rounded margin, and at its insertion the clavicular portion is seen to descend lower than the sternal, thus producing a decussation of its tendinous fibres.

Function.—To draw the arm inward and forward upon the chest. If the arms be fixed, this muscle can elevate the ribs, and thus aid in inspiration. If the arm be raised, the costal portion can draw it down; and by the action of both muscles the arms are folded upon the chest.

The *Pectoralis Minor* (Fig. 167) is triangular in shape, and seen by raising the last from its origin, and turning it over towards the humerus. It *arises* by thin tendinous digitations from the third, fourth, and fifth ribs at their superior margins, proceeds obliquely upward and outward, and is inserted by a short, flat tendon into the inner face of the coracoid process of the scapula.

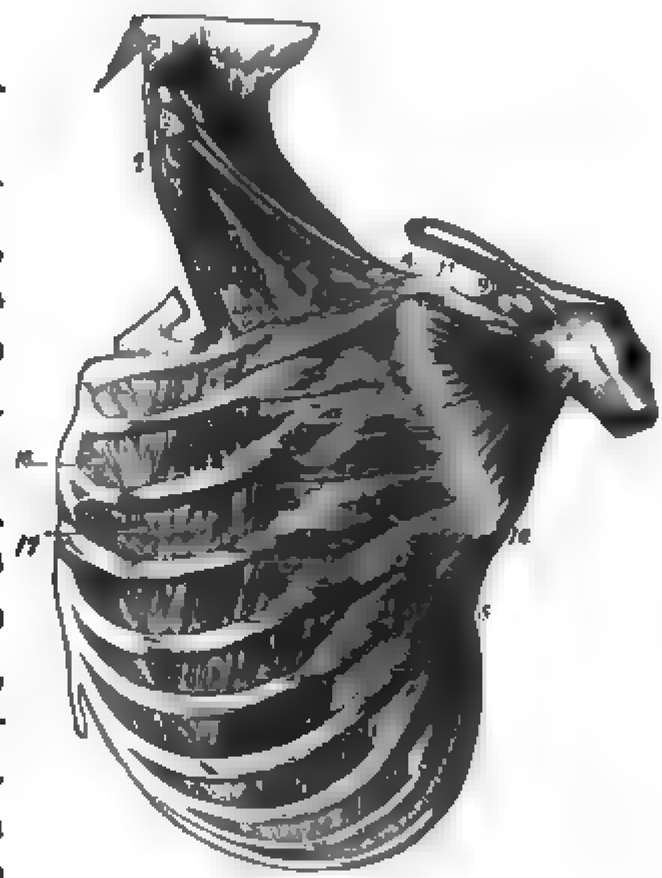
Function.—To draw the shoulder inward, downward, vnd forward, and to assist the great pectoral in inspiration, by raising the ribs, when the scapula and arm are fixed.

Serratus Major Anticus, called also *Serratus Magnus*, (Fig. 193.)—This muscle is distinctly brought to view by raising both pectoral muscles, detaching the clavicle from the ster-

num, and throwing the whole back towards the spine. It will then be seen as a thin, broad muscle, covering the sides of the chest, and situated between the ribs and the scapula.

It *arises* from the eight or nine upper ribs, by as many fleshy digitations. The five lower interlock with the external oblique muscle, the upper one is short, thick, somewhat square, and is thought to resemble a distinct muscle. Its fibres converge and are *inserted* into th whole base of the scapula.

Fig. 193.



Function.—To draw the shoulder forward, and when the scapula is fixed it can draw the ribs outward, and aid in inspiration.

The intercostales (Fig. 193) occupy the spaces between the ribs, are twenty-two in number, and divided into an *external* and *internal* set. The external *arise* from the transverse processes of the dorsal vertebræ, and from the inferior acute edge of each rib, and then proceeding downward and forward in fasciculi, are *inserted* into the superior smooth border of the rib below to within a short distance of the costal cartilage, the intervening space to the sternum

Fig. 193 represents the *Serratus Major Anticus* Muscle. 1 Anterior portion of cervical vertebræ. 2 Transverse process of the second cervical vertebra. 3 6 Scalenus anticus. 4 Levator anguli scapulæ. 5 Lower edge of serratus magnus. 7 Scalenus medius. 8 First rib. 9 Coraco-clavicular ligaments. 11 Clavicle. 12 Base of scapula, where the subscapularis is attached. 13 Upper portion of serratus magnus. 14 Lower portion of subscapularis. 15 15 Origin of serratus major anticus. 16 Internal intercostal muscles. 17 External intercostals.

being filled by aponeurosis. The *internal* arise from the sternum and inferior margin of each cartilage and rib, descend backward, decussating the external, and are inserted into the superior margin of the cartilage and rib below, as far back as the angles of the ribs. These two sets are separated by the intercostal vessels and nerves.

Function.—To raise the ribs, and enlarge the chest in inspiration, the first rib being first fixed by the scaleni.

The subclavius arises tendinous from the cartilage of the first rib, forms a small round muscle, situated immediately beneath the clavicle, and is *inserted* into the exterior half of this bone, as far back as the ligament connecting the coracoid process and clavicle.

Function.—To draw the clavicle and shoulder downward.

The triangularis sterni arises from the posterior surface and edge of the ensiform cartilage and lower part of the sternum. Its fibres run obliquely outward and upward, to be *inserted* by fleshy and tendinous digitations into the cartilages of the third, fourth, fifth, and sixth, and sometimes as high as the second rib.

Function.—To draw the ribs down and aid in expiration.

Situated upon the anterior lateral regions of the chest are the two *mammæ* or *breasts.* These are glandular organs, and belong to the conglomerate order. They rest upon the great pectoral muscles, and between the third and seventh ribs. The skin over the breast is thin, smooth, and soft, and in the virgin, of a rather pale, inclined to a bluish tint. In those who have borne children, and are advanced in life, the skin loses its smoothness and becomes wrinkled, more uneven, and of a darker color. About the centre of the gland the *nipple* is seen, which may be either long or short, sometimes so short that with difficulty the child takes hold of it. It consists of the lactiferous or milk ducts connected by cellular tissue. It presents the form of a cone in the virgin, while it has a flattened, cribriform appearance in one giving suck. It is capable of erection, and is thought by some to have the erectile tissue, while

others think it does not possess that spongy, cavernous character of the true erectile, but resembles more the dartoid structure. It is surrounded by an *areola*, which is of a rose color in the virgin, and in the pregnant or lactating female becomes of a dark brown. Both the nipple and areola present over their surface numerous small tubercles, sebaceous follicles, and nervous papillæ. Each tubercle presents near its apex three or more foramina, which are the openings of the excretory ducts from the gland composing the tubercle, and whose secretion, it is believed, is designed to protect the nipple from excoriation, while there are some who regard these tubercles as lactescent. Beneath the skin and front surface of the *mamma* an abundance of cellular tissue intermixed with globules of fat is seen, which makes the volume of the gland appear much larger than it really is.

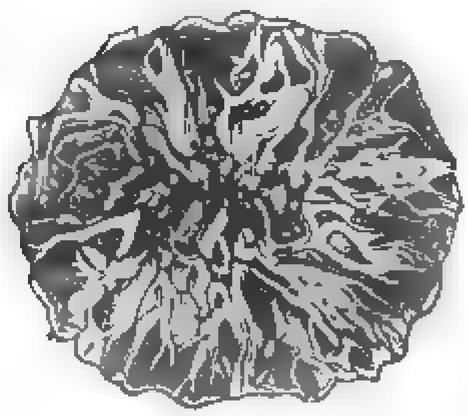
Structure.—The mammary gland is surrounded by a capsule of cellular membrane, which sends down processes into its substance, separating and connecting its different parts. It consists of lobes which are divided into lobules, and these again into granules, about the size of millet seed, which, under the microscope, are found to contain vesicles. (Fig. 17.) The lobules give the exterior surface of the gland a very uneven appearance, from being separated at different depths, by irregular fossæ which are filled with adipose and cellular tissue. From the vesicles of the several granules, the excretory or lactiferous ducts have their origin. The ducts as well as the granules are known by their white color. They converge from all parts of the gland to the base of the nipple; in their course, diminishing in number, but increasing in size. The termination of these ducts, at the base of the nipple, is in sinuses, reservoirs, or ampullæ. As many as fifteen of these sinuses are enumerated, having different diameters. From these about twelve or twenty ducts pass through the nipple to its extremity, and there open by as many orifices. These ducts (Fig. 194) are lined by mucous membrane, and when in a state of erection are doubled or folded upon them-

selves, thus forming valves to prevent the escape of the milk when not needed. These ducts, however, have no true valves, and injection shows them to have no communication with each other.

The interior of the mammary gland, when a section is made, presents a white, fibrous appearance, in which the granular arrangement is not so distinct, unless the examination, it is remarked, be made during lactation.

The *arteries* supplying this gland come from the thoracic, the intercostals, and internal mammary. The veins are superficial and deep—the latter accompanying the arteries. The *nerves* are derived from the brachial plexus and intercostals.

FIG. 194.



The *lymphatics* of the mammæ are numerous, some of which are traced to the glands of the axilla, others pass through the intercostal spaces into the anterior mediastinum, to the lymphatic glands in this situation; while others accompany the intercostal vessels to the posterior mediastinum, or enter directly the thoracic duct.

Function.—To secrete the milk designed for the nourishment of the infant. The closest sympathy exists between the mammæ and the *uterus*.

THE PLEURA, (Fig. 195.)

The pleuræ form the interior lining and complete the walls of the chest. They are two in number and consist of complete sacs without any opening, and are reflected from the walls upon the viscera which they enclose. The organs, however, are all on the outside and none within the pleural cavity. Each pleura is one continuous membrane, and can be traced throughout its whole extent. That portion covering the walls is called *pleura parietalis* or *costalis*, and that covering the lungs, *pleura pulmonalis*. The

FIG. 194 represents the Lactiferous Ducts.

form of each pleura is conical, the apex being above, and their relative situation has been compared to that of two bladders placed side by side, so as to leave a space between them. So with the two pleura, they are situated upon either side of the chest, and approach each other along the median line, having a space between them called the *mediastinum*. This space is divided into an anterior, middle and posterior, and according to some, also a superior mediastinum, each of which contains different organs. By commencing on the posterior surface of the sternum with either the right or left pleura, we trace this membrane to the front of the pericardium, thence back to the anterior root of the lungs. From the root it is reflected over the anterior surface of the lungs, and traced round upon the posterior surface to the back part of the root, whence it is reflected to the posterior pericardium, and back to the sides of the vertebræ. From this latter point the pleura stretches all along the spine, ascending as high as the sixth or seventh cervical vertebra, and as low as the diaphragm,

Fig. 195.

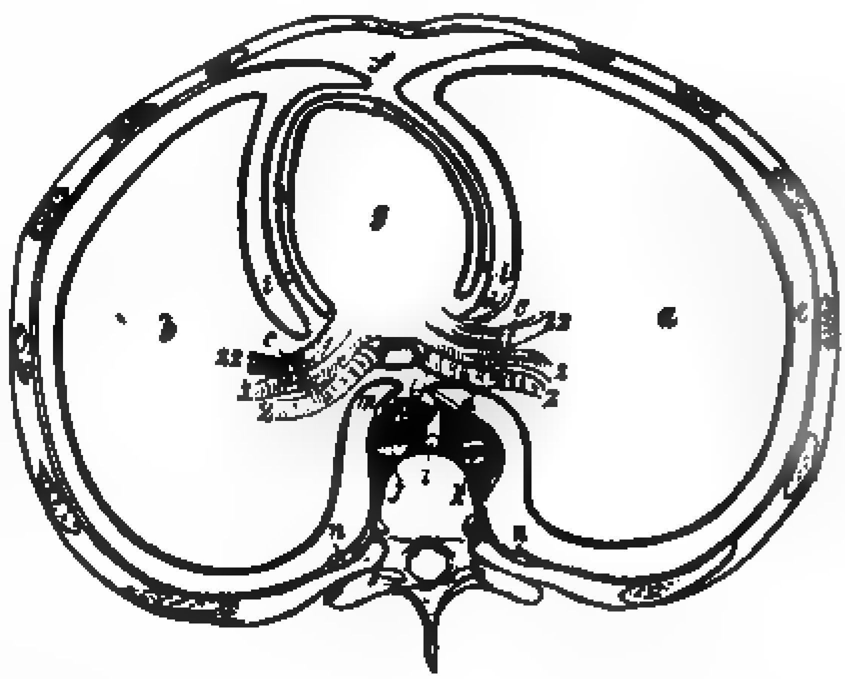


Fig. 195 represents the Pleura and its reflections from a transverse section of the chest. *a* Right lung. *b* Left lung. *c* Root of lungs, showing the relation of its vessels. 22 Pulmonary vein. 1 Pulmonary artery. 2 Bronchial tube. *d d* Reflection of pleura from root of the lung. *e* Cavity of pleura. *f* Anterior mediastinum. *g* Middle mediastinum, containing the heart. *h* Cavity of the pericardium. *i i* Direction of the phrenic nerves. *j* Aorta. *k* Vena-azygos. *l* Thoracic duct. *m* Œsophagus. *n* Sympathetic nerve. *j k l* are in the posterior mediastinum.

completely covering this latter muscle, and expanding outward from the spine over the ribs and intercostal muscles, forward to the sternum, where the sac was opened and the tracing begun, thus showing one continuous whole throughout. It is thus seen that each pleura forms a vertical septum from the sternum in front to the spine behind, and that the space between these almost parallel partitions is, as just stated, the mediastinum.

The *anterior mediastinum* is immediately behind the sternum and in front of the pericardium. Its form is triangular, the base being the sternum, the sides are formed by the two pleura, which, approaching each other very closely on the top of the pericardium, constitute the apex. It contains much fine cellular structure, some lymphatic glands, and at the superior portion the origins of the sterno-hyoid and sterno-thyroid muscles, with the remains of the thymus gland. This space is exposed by passing up one or two of the fingers behind the sternum from the abdomen, so as to break down the cellular connections between the pleuræ, then sawing the sternum longitudinally along the median line, and dividing the cartilages near the sternum.

The *middle mediastinum* contains the pericardium and heart, ascending aorta, superior vena cava, pulmonary arteries and veins, and division of the trachea, and is, as its name implies, between the anterior and the next division.

The *posterior mediastinum*, directly behind the middle, and in front of the spine, is exposed by dividing the right pleura in a longitudinal direction behind the root of the lung, and turning the latter over to the left side, when this space will be seen to contain the œsophagus and eighth pair of nerves, the descending aorta, vena azygos, thoracic duct, splanchnic nerves, a quantity of cellular tissue, and several lymphatic glands.

A reflection of the pleura from the root of the lung to the diaphragm is called *ligamentum latum pulmonis*.

Structure.—The pleuræ belong to the class of serous membranes, and are thin and transparent, with their internal surface smooth, polished, and free. Their exter-

nal surface is connected, by cellular tissue, to the adjacent parts, having varying degrees of attachment, being with much more difficulty separated at some points than others. The cellular tissue of the pleura is so condensed as to take the form of a fascia, in some places, as on the ribs, where it is strong and more readily detached than on the diaphragm or lungs. On these latter it is so thin and delicate as scarcely to admit of demonstration; and, though so extremely delicate upon the lungs, it is nevertheless asserted to be strong, resisting, and elastic, and that this transparent fascia can also be dissected off the air-cells. The pleura, then, is really a *fibro-serous membrane*, and in the healthy state has no perceptible blood-vessels.

Function.—To secrete or exhale a serous fluid upon their internal surface, by which the cavity of each pleura is kept in a constantly moist and lubricated condition, thus allowing its parietal and visceral portions to glide readily upon each other, and thereby giving both the lungs and walls of the chest the greatest freedom of motion during respiration.

SECTION II.

ORGANS OF RESPIRATION.

These comprise the *larynx*, the *trachea*, *bronchi*, and the *lungs*.

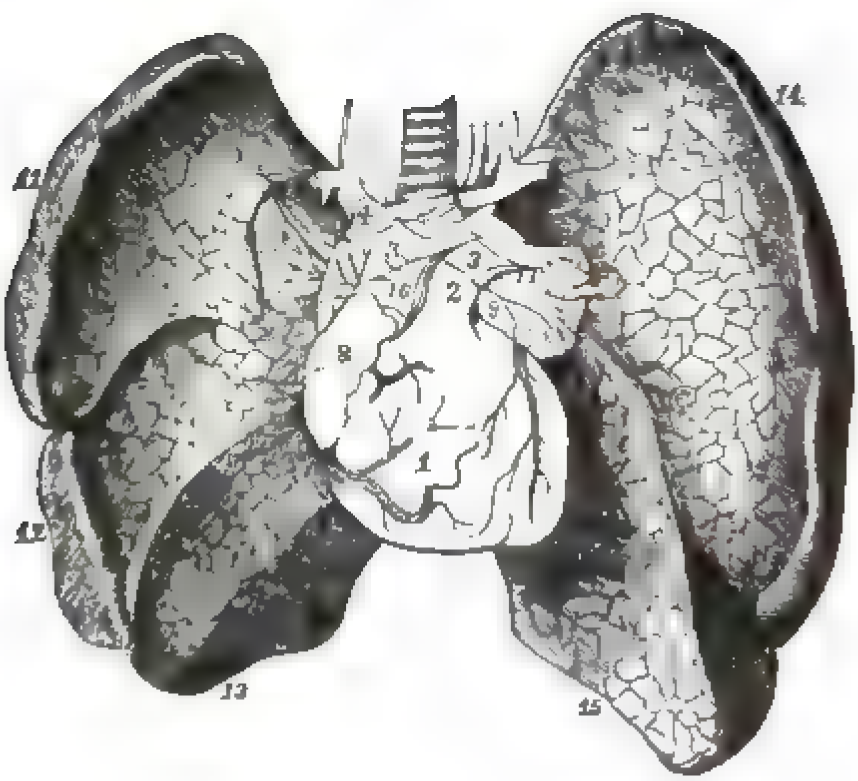
The larynx and trachea have already been described in another place; we therefore proceed to examine the lungs.

THE LUNGS, (PULMONES.)

The lungs are two in number, right and left, and *situated* upon either side of the chest, having the mediastinum and heart to separate them. When distended with air, the pleura pulmonalis and pleura parietalis are in close juxtaposition; and, strictly speaking, there cannot be said to be any thoracic cavity, as the distended lungs fill the whole space, excepting the small part occupied by the heart and thymus gland.

The *form* of the lungs is conical, the apex being above, rounded, and seen to rise from one to two inches above the level of the first rib; the base below, and concave, to correspond to the convex surface of the diaphragm. The base of the lung presents, from before, obliquely downward and backward, precisely in the direction of the diaphragm, and consequently makes the vertical extent of the lungs behind, which reach from the first to the last rib, much greater than in front, where the extent is only from the first rib to the lower end of the second bone of the sternum.

FIG. 196.



The size of the lungs is in a direct ratio with the capacity of the thorax. The average volume of air they are capable of containing, after an ordinary inspiration, is estimated at 140 cubic inches; and after expiration, at 110 cubic inches. From thirty to forty cubic inches is the average estimate of air inhaled at each inspiration.

The *specific gravity* and *density* of the lungs are less than

FIG. 196 represents the Lungs, their anterior surface, with the Heart. 1 The heart—right ventricle. 2 Pulmonary artery. 3 Left bronchus. 4 Vena innominata—its junction. 8 Right auricle. 9 Pulmonary vein. 11 Superior lobe of right lung. 12 Middle lobe. 13 Inferior lobe. 14 Superior lobe of left lung. 15 Inferior lobe.

that of any other organ. This depends on the presence of the air. Their absolute weight is less in the fœtus than after birth. In the former the proportion to the body is as one to sixty; in the latter, as one to thirty.

The *elasticity* of the lungs is very considerable, and it is by this property they are aided in the act of expiration. This property is demonstrated by the collapsing of the lungs on opening the chest. Before the chest is opened, the organs are not collapsed, as the air they contain, by the pressure from within, keeps them constantly distended; but when the chest is opened, the atmospheric pressure from without balances that within, and then the elasticity has the opportunity of exerting its influence, and produces the state of collapse.

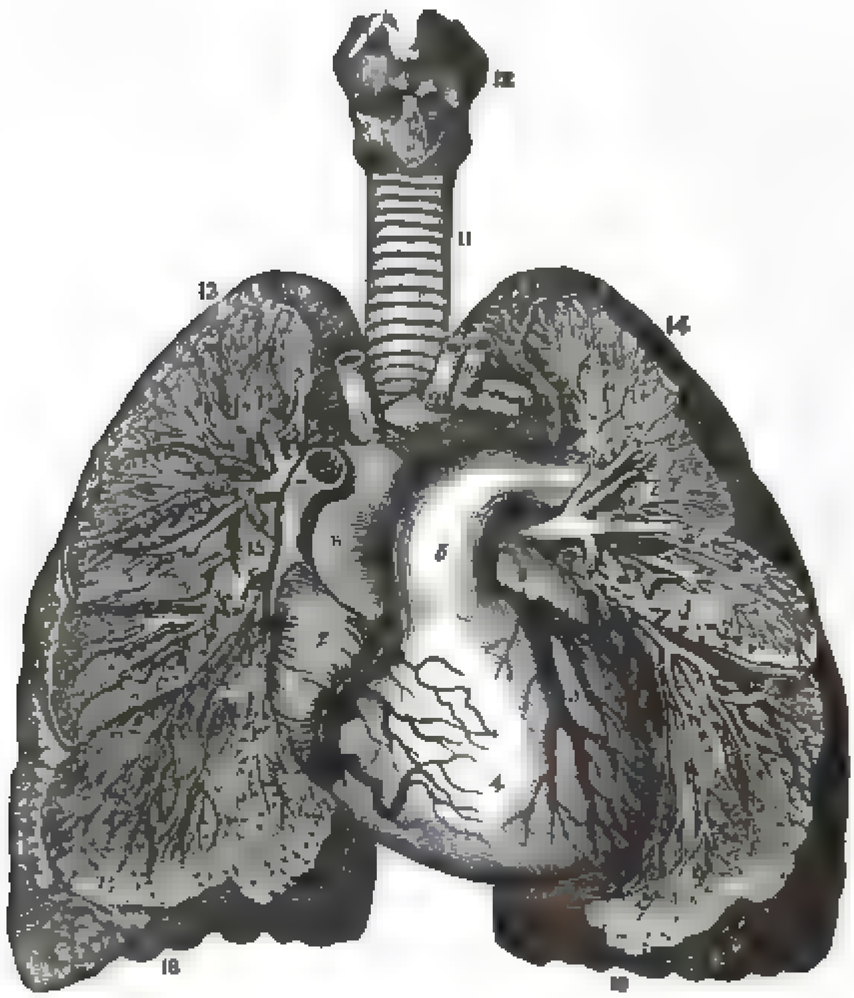
The *color* of the lungs varies according to the age. In the fœtus it is found to be of a reddish brown, after birth of a light rose or pinkish hue; in the adult it is grayish, interspersed with black, which presents the form either of lines, patches, or points, and in old age these black deposits increase.

The *surfaces* of the lungs are *external* and *internal*. The external is convex and corresponds to the concavity of the ribs, presenting a variety of different shaped figures separated by intermediate dark lines. The internal is concave for receiving the pericardium and heart. The lungs are divided into two lobes by a deep fissure commencing behind and below the apex, and descending obliquely downward and forward to the front of the base. Upon the right lung there is another fissure, which is short, and leads from the middle of the great one forward to the anterior margin, thus making another lobe for the right lung, which is in the middle, to the other two. The relative position of the two lobes is, the one superior and anterior, the other inferior and posterior. Sometimes the left lung is found with three lobes, and the right with four or more.

The anterior edge is short, thin, and oblique. The posterior edge is long, thick, round, and vertical.

The interlobular surfaces formed by the several fissures entering into the lungs, are all free, smooth, and covered

Fig. 197.



by pleura, and increase to an immense extent the area for the cells.

Structure, (Fig. 197.)—The different elements constituting the lungs are the bronchial tubes, pulmonary arteries, pulmonary veins, bronchial arteries and veins, lymphatic vessels and nerves, all connected by cellular tissue and covered by pleura. These several tissues before entering the lungs are all collected into a small compass, and known by the name of the *root* of the lungs. This root is about an inch

Fig. 197 represents the distribution of the Bronchiæ and Blood-vessels, with the relation of the Lungs and Heart. 1 Left auricle. 2 Right auricle. 3 Left ventricle. 4 Right ventricle. 5 Pulmonary artery. 6 Arch of aorta. 7 Superior vena cava. 8 Arteria innominata. 9 Left carotid artery. 10 Left subclavian. 11 Trachea. 12 Larynx. 13 Superior lobe of right lung. 14 Superior lobe of left lung. 15 Right pulmonary artery. 16 Inferior lobe of the lungs.

and a half long, half an inch wide, and situated upon the internal surface of the lung, a little above its centre. It fixes the lung on either side.

The *bronchi*, or air tubes, (Fig. 165,) form the terminating branches of the trachea, coming off about opposite the fourth dorsal vertebra, and consisting of the right and left bronchus.

The right passes beneath the right pulmonary artery to the lung, is about an inch long before dividing, and is larger and shorter than the left.

The left bronchus is about an inch longer than the right, though smaller, and passes through the arch of the aorta obliquely downward to the left lung.

The right bronchus is embraced at the root of the lung by the vena azygos; the left by the arch of the aorta. The right, on entering the lung, divides into three branches, the left into two, and both right and left then divide and subdivide into an almost infinitude of branches throughout the lungs. At the bifurcation of the trachea into the bronchia, there is observed a triangular ligament, strong and elastic, occupying the space of separation; and after entering the lung, the primitive divisions of each bronchus divide into two, and each one of these again into two, and so on dichotomously as far as they can be traced, the fine tubes ultimately terminating in the lobules, which latter compose the *air-cells*, and these again consist simply of the dilated terminations of the extended branchings of the bronchial tubes throughout the pulmonary structure.

Each bronchus, in its primitive division, like the trachea, has its cartilaginous rings deficient in the posterior third. But on entering the lungs, the rings form smaller segments of circles, and consist of small pieces placed equally round the bronchial tubes so as to constitute them cylinders. These pieces have different forms, and can overlap and glide upon each other, by means of the circular muscular coat, whose fibres are connected with the extremities and margins of these cartilages, and in this way the diam-

eter of these tubes can be diminished, and, as suggested by Dr. Physic, the expulsion of mucus greatly facilitated. These bronchial cartilages, as they proceed, become smaller and smaller till reduced to simple lines, patches, or grains, when they are finally lost and the tube becomes wholly membranous.

The cartilages of the bronchi are all connected by a continuation of the same elastic fibrous tissue, that belongs to the rings of the trachea. The extent of the muscular coat of the bronchi is not exactly determined; some are disposed to think it ceases at the last bronchial cartilage, while others carry it somewhat beyond this point upon the membranous portion towards the cells. The mucous membrane of the bronchi is a continuation of the same that lines the trachea and larynx, and is traced on into the air cells of the lungs. It is very vascular, and is seen to present a number of longitudinal folds. This membrane abounds with mucous follicles, whose orifices, upon its surface, are so numerous as to present the cribriform appearance. At the beginning of the bronchi the mucous coat is found firm, thick, and red. As it proceeds it becomes thinner and paler, till in the membranous terminations it appears transparent and of great tenuity.

The Air Cells.—These cells, which are, as just stated, the ultimate cœcal terminations of the bronchi, form clusters of cells, constituting the several lobules. Their precise form and arrangement still remain a matter of doubt, for while on the one hand they are regarded by Reisessen and his followers to be round, and related to each other after the manner of the fruit on a bunch of grapes, each grape being connected by a separate pedicle to one common stock, so it was thought that the cells of the lobules had no communication directly, but only by their ducts, which lead to a common bronchial tube; Dr. Horner's experiments seem to show conclusively, on the other hand, that the cells of each lobule communicate directly the one with the other, but not with the cells of different lobules; and the terminating bronchial branches,

which he remarks are about the size of a bristle, and distinctly seen, are supposed to have somewhat the same attachment to the lobule and its cells as a blow-pipe fixed to the side of a small piece of sponge.

The diameter of these cells is estimated from the 1-50th to the 1-200th of an inch, and they have no regular shape or size. By a calculation 18,000 of them are made to belong to each lobule, and about six hundred millions to the whole lungs, which will afford some idea of the immensity of surface provided for the reception of air, and the ample facilities for purifying the blood by such an arrangement.

The *pulmonary artery*, seemingly the next element in importance, comes from the right ventricle of the heart, beneath the arch of the aorta, and divides into two branches. The one on the right is larger, goes to the root of the right lung, and thence divides and subdivides throughout the substance of this viscus into capillary branches, which are found to terminate upon, and completely surrounding and lining the interior of the air cells. The left pulmonary artery has the same distribution, but is smaller than the right. Both these arteries convey dark, venous blood to the air cells of the lungs, where this impure blood is brought in contact with the air, and the change from dark venous into *red arterial* blood occurs, a change constituting the great leading object in the function of respiration.

The *pulmonary veins* commence at the air cells, and are formed by fine radicles from the ultimate terminations of the pulmonary artery. These all successively converge into four trunks, two for the right and two for the left lung, which take up the red blood formed in the cells, and convey it into the left auricle of the heart.

The *bronchial arteries* come from the thoracic aorta, follow the course of the blood-vessels above mentioned, ramify in every direction, and are designed for the nourishment of the lungs.

The *bronchial veins* return the venous blood into the vena azygos.

The *lymphatics* are abundant both on the surface and in the substance of the lungs, and go to the bronchial glands.

The *nerves* come from the pneumogastric and sympathetic; chiefly from the former. A plexus exists on the front and back of the roots of the lungs, called the *anterior* and *posterior pulmonary plexuses*. These nervous filaments are traced along the bronchial tubes, forming anastomoses around them, and are supposed to expand themselves upon the mucous membrane and blood-vessels.

All these different elements, constituting what is termed the *parenchyma* of the lungs, are collected and run together in the root, at which point their relation with one another is as follows: after the pleura is removed from the anterior part of the root, we see the pulmonary veins below but in front of the pulmonary artery,—this latter being above and behind the veins,—while the bronchial tube is above and behind the artery.

Function.—The function of the lungs or of respiration, is quite a complex act. This act consists in eliminating carbonic acid from the blood, and supplying its place with oxygen, or, in other words, in converting venous into arterial blood. To accomplish this object, a variety of organs are employed. The ribs and intercostal muscles, the diaphragm, the scaleni, the great and superior serrati muscles, with others, all concur in greater or less degree to enlarge the diameters of the chest, thereby increasing its capacity for the reception of air, and thus accomplishing the act of *inspiration*. The abdominal muscles, and the posterior inferior serrati, aided by the elasticity of the cartilages, draw down the ribs, and the diaphragm at the same time ascending, the diameters of the chest are diminished, thereby expelling the air from the lungs, and in this way accomplishing the second act of respiration, termed *expiration*.

The pneumogastric, intercostal, phrenic and sympathetic nerves are essential elements in putting all this machinery in motion, as well as in maintaining it in action.

THE THYMUS GLAND.

This body is noticed here from being located in the vicinity of the thoracic organs, rather than from any thing that is especially known of its physiological relationships.

It is *situated* in the anterior mediastinum, occupying a greater part of its extent. During fœtal life, and for the first year or two after birth, it descends in front of the pericardium nearly as low as the diaphragm, and ascends upon the neck as high as the thyroid gland. After the second year it commences diminishing till, at the period of puberty, scarcely a vestige of it remains. Cases, however, are not wanting in which it has been seen at from 20 to 30 years, even larger than in children, and even from 30 to 50 it has been found of considerable size. This body, though called a gland, is destitute of one of the great characteristics of a gland proper, an excretory duct. It is a symmetrical body, consisting of two lobes, of an oblong form, which are connected as well as separated by cellular tissue.

Structure.—The lobes of the thymus are divisible into lobules, which, according to the observations of Sir Astley Cooper, consist of vesicles of different sizes connected by cellular tissue, which also forms a common capsule to the gland itself. These vesicles or cells communicate with a central cavity or reservoir, which contains a milky fluid, like chyle. This cavity is lined by a vascular mucous membrane, on the surface of which the opening cells are seen. The consistence of this gland is soft, and its color of a pinkish hue.

Its *arteries* come from the *superior* and *inferior thyroid*, and *internal mammary*. Its *veins* go to the *thyroid*, and *vena innominata*. The *lymphatics* join the absorbents at their junction with the internal jugular and subclavian veins. The *nerves* are derived from the *internal mammary plexus* of the *sympathetic*.

Function.—The use of this body is yet unknown, though its great importance to fœtal life is admitted by all. Sir A. Cooper suggests that the milk-like fluid found in its cavity is furnished by it for the purpose of nourishing the

fœtus before birth, as well as for a short time after birth till chylification is fully established.

Another opinion entertained is, that it is a *diverticulum* of blood from the lungs of the fœtus, when these organs, as before birth, are known to be inactive.

SECTION III.

ORGANS OF CIRCULATION.

These organs comprise the *heart*, *arteries*, and *veins*, with the *lymphatics*, which are regarded as appendages.

Under the head of the *vascular tissue* will be found a general description of the different systems of circulation; and under the head of *organs of absorption* will be seen an account of the lymphatics. All that we propose, therefore, in this place, is to confine our remarks to the heart, and great arterial and venous trunks, by giving somewhat more in detail the description of these important organs.

THE HEART—(Fig. 10.)

The heart, styled the central organ of the circulation, is a hollow muscle. It is *situated* (Fig. 196) near the centre of the thoracic cavity, in the middle mediastinum, behind the sternum, in front of the vertebral column, between the lungs, and above the diaphragm. Its *form* resembles that of a cone, and it is divided into a base, body, and apex. Its *direction* is oblique, from above, on the right, across the spine, downward and forward to the costal ends of the fifth and sixth cartilages, on the left. Its average *length*, from apex to base, is estimated at about five inches, four of which are given to the ventricles. The base is about four inches.

Its *weight* is from six to eight ounces; though all these measurements are liable to considerable variation compatible with health.

The heart is surrounded and kept in its position by a *fibro-serous membrane*, called the *pericardium*. This membrane forms a conical bag for receiving the heart, and,

being much larger than this organ, allows it free motion within its walls. The pericardium consists of two layers, an external or fibrous, and an internal or serous.

The fibrous layer is attached below to the cordiform tendon of the diaphragm, to which it is strongly bound by compact cellular substance; laterally it is embraced by the two pleuræ; in front it corresponds to the anterior, and behind to the posterior mediastinum. Above it is traced upon the great vessels, proceeding from the heart, upon the aorta as high as the arch, upon the pulmonary artery, upon the superior cava for an inch before entering the right auricle, upon the inferior cava, and upon the pulmonary veins. It is prolonged upon the sheath of these vessels, being insensibly lost upon, and becoming identified with their external coat. In structure it is like the dura mater, though thinner. It is also white, inelastic, and semi-transparent.

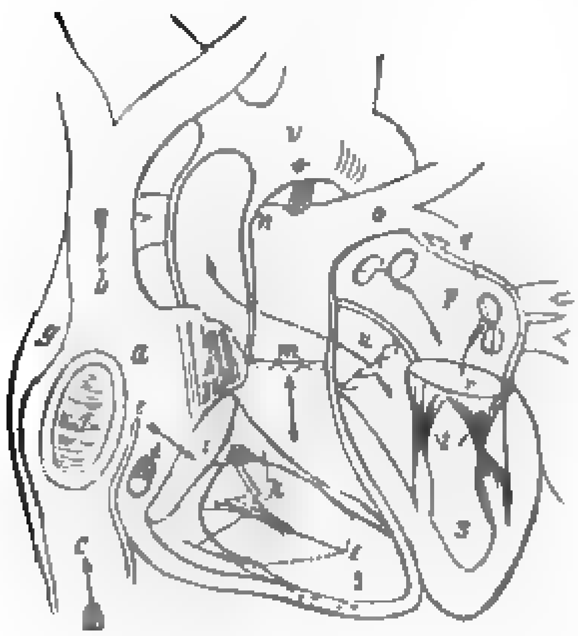
The internal layer of the pericardium is seen by opening this bag, when, like all serous membranes, it presents a smooth, polished, delicate, transparent surface, and forms a shut sack. It lines the interior of the fibrous coat, and is reflected thence upon the great vessels to the heart, whence it is traced over this organ, covering its anterior and posterior surfaces. It is connected to the heart by cellular substance, having frequently interposed a quantity of adipose matter.

Function.—The pericardium, by its fibrous coat, is of use in fixing and retaining the heart in its natural position, and preventing over-distention of its several cavities; while, by its serous layer, a fluid is furnished, which both lubricates and facilitates the motions of this organ.

The heart, as already stated, is a hollow muscle, and contains four cavities, (Fig. 198,) two of which are upon the right side, and anterior, the other two upon the left side, and posterior. The two upon the right being separated by partitions from those on the left, constitute the heart a double organ, which is distinguished into a *right* and *left* heart. Two of these cavities occupy the superior

part, forming the base, and are termed *auricles*. The other two occupy the middle and lower portions, constituting the body and apex, and are called *ventricles*.

Fig. 198.



The right heart is composed of the *right auricle* and *right ventricle*, (Fig. 199,) the left heart of a *left auricle* and *left ventricle*, (Fig. 200.) The right heart receives venous blood; the left, arterial blood.

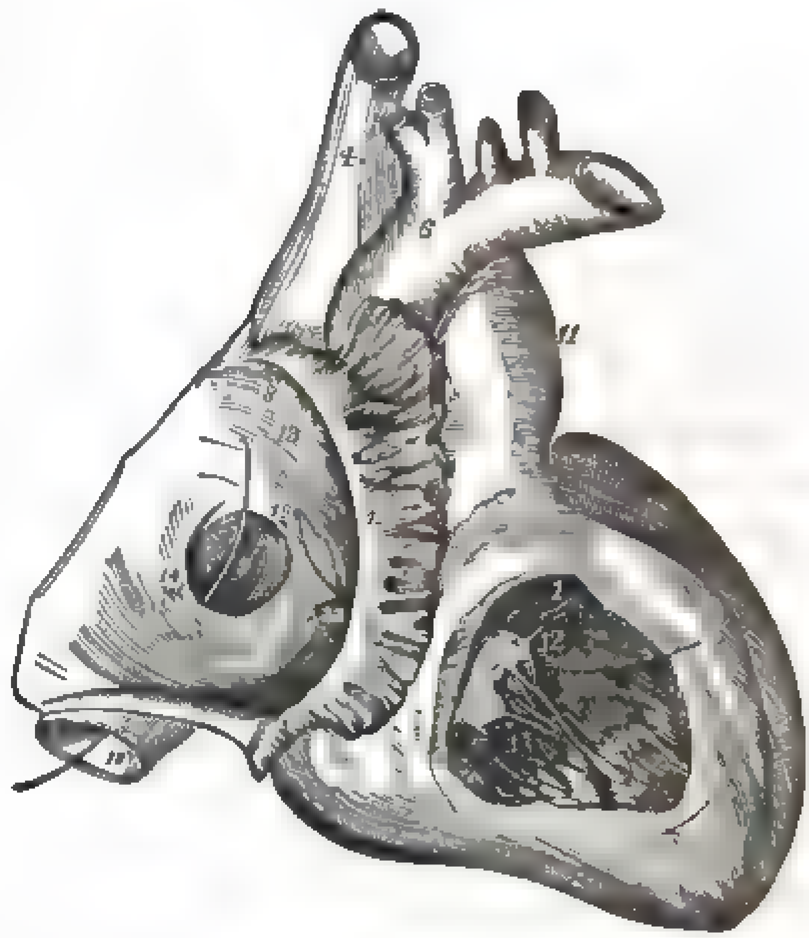
We shall examine the heart in the order of its circulation. The blood enters first the right auricle, by the superior and inferior vena cava; from this cavity it passes into the right ventricle, through the ostium venosum. From the right ventricle it goes to the lungs, by the pulmonary artery. From the lungs it returns to the left heart by the four pulmonary veins, entering at the left auricle. From the left auricle it goes through the ostium arteriosum into the left ventricle; and from the left ventricle it passes out by the aorta, to be distributed to all parts of the body.

Right Auricle.—Make an incision from the superior to the inferior cava, and cross it by another running transversely along the centre of the cavity. On washing out the blood there is seen, at the upper and posterior part, the *superior vena cava,* descending obliquely forward and

Fig. 198 represents the Cavities of the Heart. *a* Right auricle. *b* Superior cava—its entrance. *c* Inferior cava—its entrance. *d* Entrance of coronary vein, partly closed by valve. *e* Eustachian valve. *f* Fossa ovalis. *g* Tuberculum loweri. *h* Musculi pectinati. *i* Right auriculo-ventricular opening, or ostium venosum. *j* Right ventricle. *k* Tricuspid valve. *l* Chordæ-tendineæ, and carneæ columnæ. *m* Pulmonary artery—its three semi-lunar valves, seen at its commencement. *n* Right pulmonary artery. *o* Left pulmonary artery. *p* Left auricle. *q* Openings of the four pulmonary veins. *r* Left auriculo-ventricular opening, or ostium arteriosum. *s* Left ventricle. *t* Mitral valve. *u* Aorta—its commencement and semi-lunar valves. *v* Arch of aorta.

inward, about an inch within the pericardium, to enter the auricle. There is no valve at the entrance of this vein. At the lower portion of the auricle the *inferior cava* is seen to enter obliquely backward and inward, ascending within the pericardium only for a short distance.

FIG. 199.



At the entrance of this vein there is a valve, called the valve of Eustachius, which, in the adult, is very imperfect, but in the fœtus is quite large, and, according to Sabatier, is obviously designed to conduct the fœtal blood to the foramen ovale, and prevent the mixing of the superior and inferior streams. This valve is formed by a doubling of the lining membrane of the auricle, surrounding about one half of the front of the inferior cava, and stretching between this vessel and the fossa ovalis, with which it is connected.

Between the two cava, about midway, is seen a transverse prominence, called *tuberculum Loweri.* The direction of the blood, entering the auricle by these two veins, is such,

FIG. 199 represents the right Heart laid open. 4 Superior cava. 8 Its entrance into right auricle. 18 Inferior cava—its entrance into the right auricle. 13 Smooth portion of right auricle. 14 Eustachian valve. 15 musculi pectinati. 9 Fossa ovalis, or remains of foramen ovale. 19 Annulus ovalis. 22 Opening of coronary vein. 1 Cavity in right ventricle, leading to the pulmonary artery. 11 Pulmonary artery. 12 Septum between ventricles. 3 Tricuspid valve. 6 Aorta.

says Mr. Wilson, that a stream forced into the superior, takes a course towards the ostium venosum, or right auriculo-ventricular opening—while the inferior current is directed to the septum auricularum, or *fossa ovalis*, the natural course of the blood in the fœtal state. The outer and posterior walls of the auricle are dilated into a pouch called its *sinus*, while the superior projecting extremity, with indented edges, from its resemblance to the ear of the dog, gets the name of auricle.

This portion, together with the sinus, has a number of fasciculi of muscular fibres running parallel to each other, and called, from their resemblance to the teeth of a comb, *musculi pectinati*. Between these fasciculi the spaces contain no muscular fibre.

The internal wall of this cavity consists of a thin partition called the *septum auricularum*, which separates it from the left auricle. On the lower part of this septum a depression is seen, the *fossa ovalis*, the margin of which all round is thick and elevated, and termed *annulus ovalis*. This fossa ovalis corresponds to the opening in the fœtus called *foramen ovale*, through which the blood passed freely and directly from the right auricle to the left, but which, after respiration is established, becomes closed by the septum just mentioned.

To the left of the Eustachian valve is seen an orifice about the size of the common quill; this is the opening of the coronary vein of the heart, and is protected by a semilunar valve called the *valve of Thebesius*, which is formed by a duplication of the lining membrane of the auricle, and prevents the blood from regurgitating into the vein. At different points of the auricle, small orifices are seen, called *foramina Thebesii*, some of which are regarded as the terminations of veins, while others simply lead into the muscular depressions.

Right Ventricle.—The passage from the right auricle into the right ventricle is through a large, round opening, the *ostium venosum* or *right auriculo-ventricular* opening. A dense white line, termed the right tendon of the heart,

surrounds this opening. By making one incision along the right side of the heart, and another along the septum cordis, and turning up a flap from below, this cavity will be exposed. Its form is triangular, with the base above and connected with the auricle, while its lower extremity stops a little short of the apex of the heart. The right ventricle occupies the anterior and right side of the heart, and has its walls much thicker than those of the auricle, being estimated about three lines, while the latter is but one line.

Its interior surface is very irregular from numerous muscular fasciculi called *columnæ carneæ*. These fleshy columns are differently arranged; some are connected along their whole length; others are fixed by their extremities; while others again are only attached by one extremity, having the other free, to which is connected several round, tendinous chords called *chordæ tendineæ*. These chords interlace among themselves, and are, with the valve, placed between the right ventricle and auricle. This valve is formed by a fold of the lining membrane projecting from the auriculo-ventricular opening, and, from being divided into three pieces, is called *tricuspid*. One of these pieces is posterior, on the septum cordis; a second is anterior and the largest, separating the auricular from the pulmonary arterial orifice, while the third is to the right side. This valve prevents the blood, during the contraction of the ventricle, from returning back into the auricle, which is done by the columnæ carneæ contracting, and putting upon the stretch the chordæ tendineæ, which draw the several pieces of the tricuspid to each other, while at the same time the blood gets behind, and thus assists to approximate as well as support them, and prevent their being forced open.

At the superior and left extremity of the right ventricle, is seen the orifice of the pulmonary artery. This orifice is smooth and round, about an inch in diameter, and protected by three valves, termed *semilunar* or *sigmoid*. These valves are formed by a duplication of the lining membrane of the

artery, being connected to the latter by their circumference, and having, in the centre of each loose edge, a little white or yellowish body called *corpusculum Arantii.* These corpuscles serve as abutments to support each other when the valves are brought together, and thus prevent the blood from regurgitating. Exterior to these valves, and between them and the artery, are three pouches called the *sinuses of Valsalva.*

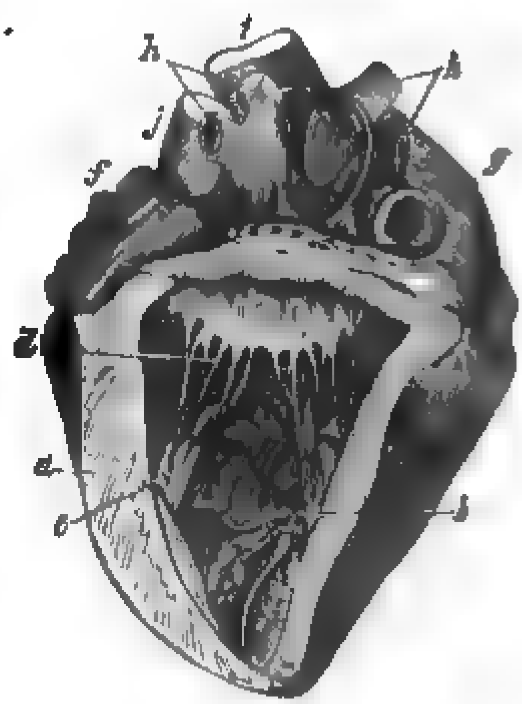
The *pulmonary* artery ascends obliquely backward to the under part of the arch of the aorta, where it divides into two branches, one for each lung. The right is both longer and larger; it goes behind the aorta and superior cava to the root of the right lung, where it divides into three branches. The left is shorter, and goes in front of the descending aorta to the root of the left lung where it divides into two branches. The distribution of these branches has been already given in the description of the lungs. Where the pulmonary artery divides into its right and left branches, a ligamentous cord is seen to extend backward and downward to the lower extremity of the arch of the aorta. This, in the fœtus, was an open tube called the *ductus arteriosus*, through which passed to the aorta the balance of the blood which failed to go through the foramen ovale, the pulmonary arteries carrying to the lungs only so much as was just sufficient for their nutrition.

Left heart, (Fig. 200,)—*Left auricle.*—The pulmonary veins, four in number, two from each lung, return the blood, after it has been changed from venous into arterial, into the left auricle. This auricle is situated at the superior and back part of the base of the heart, being hid by the ventricles and right auricle. Its shape is more of a square than the right, and it has a pulmonary vein entering each of its angles. It consists, like the right, of a sinus and appendix. Its walls are thicker and stronger than those of the right auricle, though its cavity is smaller. Its appendix contains the *musculi pectinati*, and is more indented, crooked and narrower, than that of the right. At the inferior part of this auricle is seen the opening into the left ventricle,

called *ostium arteriosum*, or the left *auriculo-ventricular* opening.

Left ventricle.—This cavity presents a conical form, and is posterior to the right ventricle. Its base is above, and apex, which is below, projects beyond the right, and constitutes the apex of the heart. Its walls are about three times as thick as those of the right ventricle, and it has the same arrangement of *columnæ carneæ* and *chordæ tendineæ*, as the right, only thicker and stronger.

Fig. 200.



The partition between the two ventricles is styled the *septum cordis*. It consists of a thick muscular wall, formed mostly by the left ventricle. At the upper and back part of this cavity the left auriculo-ventricular opening is seen, and is found to be protected by a fold of the lining membrane projecting from round the margin of this orifice into the ventricle, and dividing into two portions, called the *mitral valve.* The margin of this opening consists, as in the right, of a white and dense tendinous structure.

The anterior division of the mitral valve is larger and broader than the posterior, and covers, in a great measure, the aortic opening. This valve, as well as the tricuspid, contains the fibrous structure, is attached by tendinous chords to the columnæ carneæ, and serves to prevent the reflux of blood into the auricle.

The orifice of the aorta is seen in front of the auricular opening, and, like that of the pulmonary artery, is guarded

Fig. 200 represents the left Ventricle laid open. *a* Parietes of left ventricle. *b* Its cavity. *c* Mitral valve. *d* Chordæ tendineæ. *e* Columnæ carneæ. *f* Right auricle. *g* Left auricle. *h h* Four pulmonary veins. *i* Aorta. *j* Pulmonary vein.

by three semilunar valves, having the same provision of *corpuscula Arantii* and *sinuses* of *Valsalva*, but larger and stronger, and having a similar function of preventing the reflux of the blood. The capacity of the different cavities of the heart is very nearly the same, and is estimated at about two ounces.

Structure.—Several elements enter into the composition of the heart. There is first and most external, the reflected serous layer of the pericardium, covering the whole of the outer surface, and already described. On the inner surface, and lining the auricles and ventricles, is seen a very delicate and transparent serous membrane, called the *endocardium.* It is strongly attached to the muscular fibres of the columnæ carneæ and musculi pectinati, filling up their interstices, rendering smooth the whole interior surface of the several cavities, and by its duplications forming the different valves found between the auricles and ventricles, and at the mouths of the aorta and pulmonary artery.

Between the outer and inner membrane is situated the muscular structure. This is the most abundant and important element of the heart. Its fibres are difficult to trace, and it is advised to submit them to boiling, maceration, putrefaction, and hardening in alcohol, as some of the necessary preparatory means to a successful dissection. According to *Cruveilhier*, this element of the ventricles "is composed of two muscular sacs, contained within a third, which is common to both ventricles." All the mus-

Fig. 201.

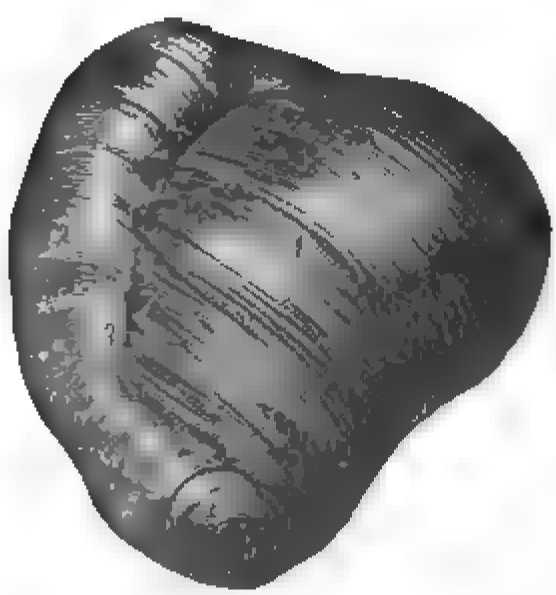


Fig. 201 represents the spiral course of the muscular fibres of the Heart, chiefly those of the left ventricle. 1 Left ventricle. 2 Right ventricle. 3 Septum of the ventricles. 4 Muscular fibres making a spiral turn around. 5 The apex.

cular fibres are traced to the fibrous zones or tendinous circles of Lower, which are situated at the auriculo-ventricular, and arterial orifices, and constitute the *frame-work* of the heart.

These fibres are divided into the *superficial* or *common*, and *deep* or *reflected*. The superficial are traced from the base of the heart, taking a spiral course to the apex—those on the anterior portion going from right to left, and those on the posterior from left to right, meeting and decussating at the apex. From this latter point, where they turn round upon themselves, they are reflected upward, and constitute the deep layers. Those belonging to the anterior superficial set form, by their reflection, the deep layer of the posterior wall, while those of the posterior superficial set constitute the deep layer of the anterior wall. Between these two sets, an intermediate one, called the *proper* fibres of each ventricle, is seen. They are compared to a small barrel or truncated cone, their superior openings corresponding with the orifices between the auricles and ventricles, while their inferior are observed to leave two considerable spaces, which are simply occupied by the common fibres. This accounts for the apex of the heart being weaker than any other portion of the ventricles.

The muscular fibres of the auricles are also divided into a *superficial* and *deep* set. The former, the fibres common to both auricles, occupy their anterior surface, and run transversely from right to left. The deep set, or *proper fibres* form a uniform circular layer. Some of them are also oblique, and constitute a muscular sphincter round the several orifices of the auricles. The muscular layer of the right auricle is not so uniform and continuous as that of the left. The septum of the auricles also contains muscular fibres, which form a ring round the fossa ovalis. At the septum of the ventricles, the right and left hearts are capable of separation, if carefully done.

The *arteries* of the heart come from the aorta, and are the first branches given off at its origin. They are the *right* and *left coronary*.

The *right coronary artery* arises above the anterior semilunar valve in front of the aorta, makes its appearance between the right auricle and ventricle, and following the course of the groove between these two to the posterior part, distributes branches as it proceeds to the right auricle and right ventricle.

The *left coronary artery* comes from above the left semilunar valve, and, while concealed by the pulmonary artery, divides into two branches, a superior and inferior. The superior passes round the groove between the left auricle and left ventricle to the back of the heart, and supplies these two cavities with branches. The inferior division descends along the septum of the ventricles to the apex of the heart, supplying with branches both ventricles, and anastomosing freely with the other coronary branches.

The *coronary veins* return the blood of the heart, and are distinguished into the *greater* and *lesser* coronary. The *greater coronary vein* begins at the apex of the heart, by the union of several branches, and then ascends along the anterior septum of the ventricle, to terminate finally in the right auricle, at its posterior inferior part, to the left of the inferior cava, where it is guarded by a valve. Throughout its whole course it is constantly receiving streams.

The *lesser coronary vein* returns the blood, mostly of the right ventricle, and discharges it into the greater coronary just as the latter is entering the right auricle. Some smaller veins are also described about the roots of the aorta and pulmonary artery, discharging into the right auricle by several orifices.

The *nerves* of the heart come principally from the *cardiac plexus* of the *sympathetic*, and follow the course of the coronary arteries. Branches also are traced from the *par vagum.*

Function.—The office of the heart has already been stated to be, to circulate the blood, in which function it is the prime agent. The venous blood is returned from all parts of the body by the ascending and descending cava, and coronary vein, into the right auricle of the heart. This

auricle, by its muscular apparatus, contracts, and throws the blood through the ostium venosum, into the right ventricle. This ventricle now contracts and propels the blood into the pulmonary artery; the tricuspid valve preventing its return into the auricle. The pulmonary artery conducts the blood to the air cells of the lungs, where it is changed from venous into arterial, as already explained under the head of respiration, and its return to the ventricle is prevented by the semilunar valves placed at the mouth of the artery. From the lungs it is carried by the four pulmonary veins to the left side of the heart, into the left auricle, thus completing a circle from the right to the left auricle, called the *pulmonic* or *lesser circulation.*

The left auricle now contracts and throws the blood through the ostium arteriosum, into the left ventricle, which in turn contracts and propels it into the aorta; the mitral valve between the auricle and ventricle, and the semilunar valves at the mouth of the aorta, preventing any regurgitation. From the aorta it passes to every part of the system, returning by the vena cava to the right side of the heart, and thus completing another circle called the *systemic* or *greater circulation.*

In the passage of the blood through the heart, two distinct sounds are heard, known as the *sounds of the heart.* The *first sound* is dull, prolonged, and corresponds with the contraction of the ventricles, and the impulse of the heart against the ribs. The *second sound,* compared to a click, is sharp, clear, and quick, and corresponds to the diastole of the heart. The two sounds embrace one arterial pulsation. The two auricles contract synchronously, so likewise the two ventricles. The *first sound,* it is believed, results from the *contraction* of the muscular fibres of the ventricles, the impulse of the heart's apex against the ribs, and the rush of the blood through the aorta and pulmonary artery. The *second sound* is thought to arise from the sudden filling and quick closure of the semilunar valves, by the reflux of the blood during the diastole of the ventricles, and the recoil of the elastic coat of the arteries; other opinions are enter-

tained in reference to the origin of these sounds, which it is not thought necessary to notice further in a work like the present.

THE AORTA, (Fig. 8.)

The origin, course, and termination of the aorta, together with a general outline of its primary and prominent secondary branches, will be found under the head of the vascular tissue. A detail of the several branches, supplying the various organs contained in the cranial, abdominal, and thoracic cavities, the exceptions hereafter to be noticed, have also been given in connection with the examination of each of these organs. So that all we propose, in the present place is, a brief recapitulation of the primary branches of the aorta, in the order in which they successively arise from this tube, and the organs and viscera to which they are respectively distributed, so as to fix, more firmly in the memory, the chain of connection between these two great classes of organs, and their relative dependency.

The *aorta*, it is known, comprises the great trunk or arterial half of the general or systemic circulation. Commencing in the upper portion of the left ventricle of the heart, concealed by the pulmonary artery, it ascends to the right side, on a level with the second rib and its cartilage; then crosses behind the sternum, about an inch below its upper edge, to the left side, when it turns downward and inward to the third or fourth dorsal vertebra. To this point a curvature is described, constituting the *arch* of the aorta, which consists of an ascending, transverse, and descending portion. From the arch, the aorta continues descending upon the left side of the vertebral column, through the thoracic cavity, to the diaphragm, to which point it is called *thoracic aorta.* Passing beneath the crura of the diaphragm, it enters the abdomen and traverses this cavity upon the median line, to the space between the fourth and fifth lumbar vertebræ, where it terminates by dividing into the *common* or *primitive iliac arteries.*

This portion is styled the *abdominal aorta*. The first branches given off by the aorta, are those supplying the heart, and consist of the *right* and *left coronary*. The next branches in order are those coming off from the arch, and are the *arteria innominata*, the *left carotid*, and the *left subclavian*, which supply the neck, head, upper extremities, and part of the walls of the chest.

The branches of the *thoracic aorta* (Figs. 8 and 214) come next, and consist of the *bronchial arteries*, which go to the lungs; the *œsophageal*, five or six in number, to the œsophagus; the *posterior mediastinal* to the mediastinum; and the *intercostal* to the intercostal spaces and walls of the chest. The *superior intercostal* comes from the subclavian. All these arteries are in pairs.

The *abdominal aorta*, (Figs. 8 and 214,) the last portion of this tube, gives off the *phrenic* to the diaphragm. The *cœliac*, a single trunk, divides into three branches—the *gastric*, *hepatic*, and *splenic*, which go to the stomach, liver, and spleen.

The *superior mesenteric artery*, about an inch below the cœliac, supplies the small intestines, the right ascending, and transverse portion of the large intestine.

The *emulgent* or *renal arteries*, two in number, come off at right angles, and go to the kidneys.

The *spermatic*, long and small, descend to the testicles. These are sometimes branches of the renal.

The *inferior mesenteric*, a single trunk, supplies the left colon and rectum.

The *lumbar arteries* are in pairs, from three to five in number, and supply the abdominal walls.

THE SUPERIOR AND INFERIOR VENA CAVA, (Fig. 9.)

These two great veins, called also the ascending and descending cava, with the coronary, return all the blood of the body, and constitute the venous portion of the systemic or general circulation.

The descending or superior cava returns to the right auricle of the heart all the blood of the body from above the diaphragm.

The sinuses of the brain, emerging at the base of the cranium, become the internal jugular veins, which, with the external jugulars, descend the neck, and at the root of the latter unite with the subclavian upon either side, and form the right and left *vena-innominata*, the junction of which, behind the cartilage of the first rib upon the right side, constitutes the *superior cava.*

This great vein is about three inches in length, and descends within the pericardium to enter the upper portion of the right auricle. It has in front of it the remains of the thymus gland and some cellular structure; behind is the right pulmonary artery and the pulmonary vein; upon the right is the phrenic nerve and right lung; upon the left or internally is the ascending aorta. Just as it enters the pericardium it receives at its posterior part the vena azygos.

The *vena azygos* (Fig. 9) returns the blood chiefly of the parietes of the chest. It commences in the abdomen, opposite the second lumbar vertebra, by branches from the superior lumbar veins, and sometimes also from the renal and spermatic, with an occasional branch from the inferior cava. Thus formed, it ascends through the aortic opening in the diaphragm to the thorax, and continues upward in the posterior mediastinum upon the right side of the vertebral column, having the thoracic duct and aorta upon its left, and the splanchnic nerve upon its right. It increases in size as it ascends, and about the fourth dorsal vertebra arches over the root of the right lung to terminate in the superior cava, where a valve is found to prevent regurgitation.

This vein in its course receives the intercostal veins of the right side, the *azygos minor* or *vena hemiazygos* of the left side, which is formed from the superior left lumbar veins, and as it ascends receives the six or seven left inferior intercostals. It crosses the spine about the sixth or seventh dorsal vertebra behind the aorta and thoracic duct, and joins the right or great vena azygos. The five or six left superior intercostal veins constitute what has been

called a superior vena azygos, which empties into the left vena innominata, and connects also with the lesser azygos. The vena azygos also receives the bronchial, œsophageal, and mediastinal veins.

The *inferior* or *ascending cava* (Fig. 9) returns all the blood of the body from below the diaphragm. The two primitive or common iliac veins, formed by the junction of the external and internal iliacs at the sacro-iliac articulation, converge upon the right side, and unite upon the ligament between the fourth and fifth lumbar vertebræ to constitute the commencement of the *ascending cava.*

This great vein now ascends upon the right side and partly in front of the spinal column, on the right psoas muscle, and right crus of the diaphragm, having the aorta upon the left—enters the fissure in the posterior part of the liver, and ascends through the tendinous opening in the diaphragm, to which it strongly adheres, to terminate in the inferior and back part of the right auricle. In its course it receives the *lumbar, renal, spermatic, phrenic,* and *hepatic* veins.

The veins of the stomach, pancreas, spleen, and intestines, go to form the great *portal vein,* which is described under the head of the vascular tissue.

NERVES OF THE THORAX AND ABDOMEN.

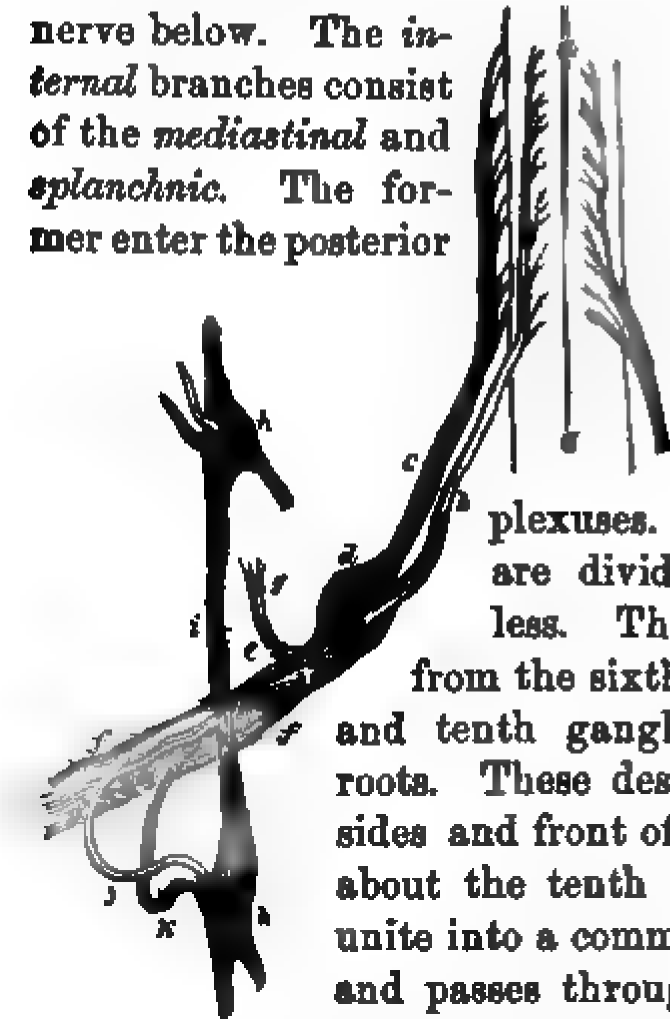
These nerves comprise the *sympathetic,* the *thoracic spinal,* the *lumbar spinal, pneumogastric,* and *phrenic.*

The *sympathetic* in the chest (Fig. 155) consists of twelve dorsal ganglia with their several branches. The ganglia are *situated* upon the heads of the ribs, covered by the pleura costalis and a thin fascia. Their form is triangular and flat, the apex external, and the base, looking to the spine. They are small, and present the usual gray color and pearly lustre of the rest of the ganglia composing the sympathetic system. They are connected above and below to each other by branches called *superior* and *inferior.* The other branches are *external* and *internal.*

The external branches, two and sometimes more, or only

one in number, pass obliquely upward and outward to join the corresponding spinal nerve, though a twig is sometimes sent to the intercostal nerve below. The *internal* branches consist of the *mediastinal* and *splanchnic*. The former enter the posterior mediastinum, following the course of the intercostal arteries to the aorta on both of which they ramify in the form of plexuses. Other branches are traced upon the œsophagus, the longus colli muscle, and into the cardiac and pulmonary plexuses. The *splanchnic* nerves are divided into the great and less. The *great splanchnic* comes from the sixth, seventh, eighth, ninth and tenth ganglia, by several distinct roots. These descend obliquely upon the sides and front of the dorsal vertebræ, to about the tenth or eleventh, where they unite into a common trunk, which is large and passes through the diaphragm either by piercing it, or along with the aorta to terminate in the semilunar ganglion. The *lesser splanchnic* derives its roots from the tenth and eleventh ganglia. These roots, uniting, enter the abdomen through the crus of the diaphragm, external to the great splanchnic, and go to the renal plexus.

FIG. 209.



The *sympathetic* nerve in the abdomen (Fig. 155) comprises the *semilunar ganglion* and its various plexuses, with the *lumbar ganglia*.

The *semilunar* ganglion is situated upon either side of the cœliac artery, and by some is regarded as the grand

FIG. 209 represents the connection of the Sympathetic Nerve with the Spinal. *a a* Anterior fissure of the spinal marrow *b* Motor or anterior root of the spinal nerve. *c* Posterior root. *d* Ganglion on the posterior root. *f f* Spinal nerve. *e* Its posterior branch. *g* Its anterior branch. *h h* Two thoracic ganglia of the sympathetic. *i* Sympathetic trunk connecting the ganglia. *j k* Two filaments uniting the sympathetic and spinal nerve.

centre of the sympathetic system. It consists of a series of ganglia, more numerous on the right than the left side, about an inch in length and presenting a semicircular form; several of these are sometimes fused into one. They all communicate and send off an immense number of radiating filaments, constituting the solar plexus.

This plexus (Fig. 203) is situated behind the stomach, above the pancreas, and within the epigastric region, and receives branches from the lesser splanchnic, the phrenic, and the right vagus. From this central and great plexus, nervous filaments proceed in every direction, and mostly follow the course of the arteries, around each of which they form a plexus, receiving its name from the artery it accompanies. Thus we have enumerated the following different plexuses:

The *phrenic,* composed of branches coming from the solar plexus, accompanies the phrenic arteries to the diaphragm.

The *gastric* plexus goes along the coronary artery to the stomach, where it communicates with the vagi.

The *hepatic* plexus takes the course of the hepatic artery to the liver. Branches also accompany the vena portæ and right gastro-epiploic artery to the greater curvature of the stomach.

The *splenic* plexus follows the splenic artery to the spleen, sending off branches to the pancreas and head of the stomach, and along the left gastro-epiploic artery to the greater curvature of the stomach.

The *superior mesenteric* plexus surrounds the superior mesenteric artery, and its branches supply the small intestines, cœcum, ascending, and transverse colon.

The *renal* plexus attends the renal arteries to the kidneys. This plexus gives off filaments to the supra-renal capsules, called *supra-renal plexus*, and also filaments along the spermatic artery, called the *spermatic plexus*, to the testes of the male, and ovary of the female.

The *inferior mesenteric* plexus follows the course of the inferior mesenteric artery, and supplies the descending

and sigmoid flexure of the colon. It sends off filaments called the *hæmorrhoidal* plexus, which follow the hæmorrhoidal arteries to the rectum.

The *lumbar ganglia* are four or five in number, situated upon the bodies of the lumbar vertebræ, and connected with the thoracic by a cord which descends behind the diaphragm close to the spine to join the first lumbar ganglion. These ganglia also send off *external* and *internal* branches. The external communicate by two or three branches with the lumbar nerves. The internal surround the aorta, forming the

FIG. 203.

Aortic Plexus.—This plexus receives filaments from the inferior mesenteric, and descends into the pelvis, where, in front of the sacrum, it forms the *hypogastric plexus*. This latter plexus communicates with the sacral, and sends filaments to the pelvic organs, which will be noticed in another place.

The *thoracic spinal nerves* (Fig. 14) are twelve in num-

FIG. 203 represents the plexuses of the Sympathetic Nerve. *l* Dorsal ganglia of the sympathetic, with the roots of the great splanchnic nerve arising from them. *m* Lesser splanchnic nerve. *o* Solar plexus. *n* Renal plexus. *p* Mesenteric plexus. *q* Lumbar ganglia. *r* Sacral ganglia. *s* Vesical plexus. *t* Rectal plexus. *u* Lumbar plexus (spinal.) *v* Rectum. *w* Bladder. *x* Pubis. *y* Crest of ilium. *z* Kidney. *a a* Aorta. *b b* Diaphragm. *c c* Heart and cardiac plexus. *d d* Larynx.

ber on each side. They arise by filaments from the anterior and posterior root of the spinal marrow, and pass out through the intervertebral foramina; each nerve then divides into an *anterior* and *posterior* branch. The anterior branches occupy the intercostal spaces, pursue the course of the intercostal arteries, and are called the *intercostal nerves*. Each receives two branches from the thoracic ganglia of the sympathetic, and then runs along the groove on the under margin of each rib, between the two laminæ of the intercostal muscles. The five or six upper intercostal nerves pass round to the sternum, and when near the latter, emerge from between the intercostal muscles, and are distributed upon the pectoral muscles and integuments. The five or six lower nerves supply the abdominal muscles and their integuments.

The first anterior thoracic nerve joins the last cervical, and sends a branch on the inner face of the first rib, which goes to supply the intercostal muscles. The second anterior thoracic, or dorsal nerve, in addition to the ordinary distribution, sends a branch between the ribs, which passes outward to the axilla, there joins the internal cutaneous of the upper extremity, and then descends the arm, distributing filaments upon the integuments as far as the elbow. The third anterior dorsal also sends a branch to the axilla, which supplies the integuments on the inner side of the arm. These nerves are called *intercosto-humeral*, or the *nerves of Wrisberg*, and are supposed to explain the numbness of the arm in angina pectoris.

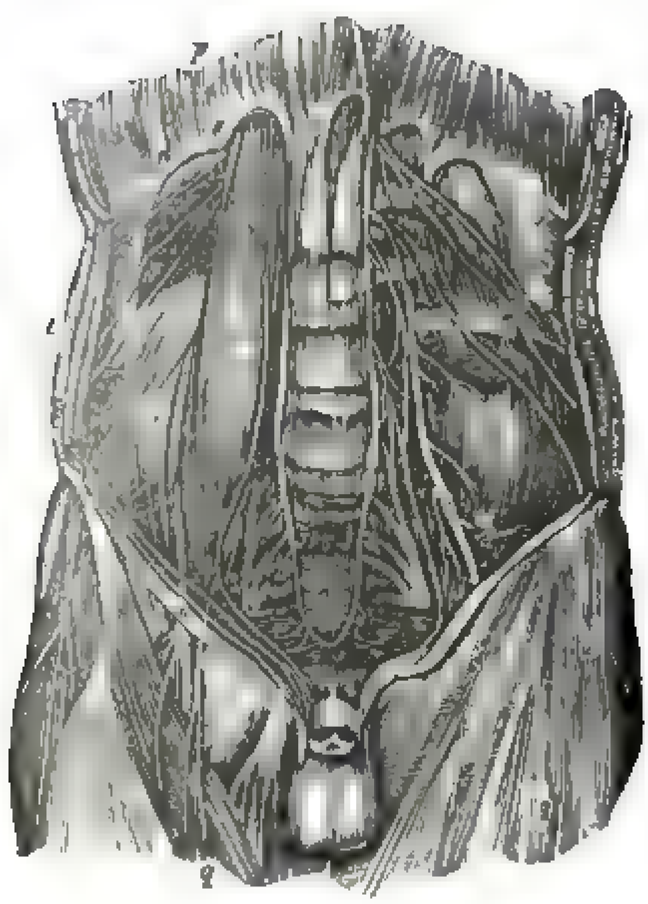
The *lower intercostal nerves*, about the middle of the ribs, send off branches, called *external pectoral*, which are spent upon the muscles and integuments upon the side of the chest. The continued nerve, which is the intercostal proper, emerges, as already stated, near the sternum, and supplies the pectoral muscles, mamma, and integuments on the front of the chest.

The *posterior* branches of the dorsal spinal nerves are smaller than the anterior. They pass backward between the corresponding transverse processes of the vertebræ,

and divide into *external* and *internal* branches. The former supply the longissimus dorsi, sacro-lumbalis, trapezius, rhomboid, latissimus dorsi, and adjacent integument. The internal supply the multifidus spinæ, the long muscles of the back, and can likewise be traced to the integuments.

The abdominal spinal, or lumbar nerves.—These consist of five pairs, and are larger than the dorsal. They pass through the intervertebral foramina, the first pair between the first and second lumbar vertebræ—the fifth between the last vertebra and the sacrum. Like the dorsal, these nerves consist of *anterior* and *posterior branches*. The *anterior* are the largest, and pass through and behind the psoas magnus, uniting with each other to constitute the *lumbar plexus*. The *first lumbar* unites with the last dorsal.

FIG. 204.



The *lumbar plexus* is concealed by the psoas magnus muscle, and is situated upon the sides of the lumbar vertebræ in front of their transverse processes.

The branches of this plexus are divided into the *superficial* and *terminal*. The *superficial* are again divided into the *abdomino-crural* and *genito-crural*, and consist, accord-

FIG. 204 represents the Lumbar and Ischiatic Plexuses. *a* Lumbar plexus. *b* Ischiatic plexus. *c c* Abdominal crural nerves. *d* External cutaneous nerve. *e f g* Cutaneous branches from *h* Anterior crural nerve. *i* Genito-crural. *j j* Termination of the sympathetic. *k* Iliacus internus muscle. *l* Broad muscles of the abdomen. *m* Psoas magnus. *n* Bodies of lumbar vertebræ. *o* Quadratus lumborum. *p* Diaphragm. *q* Sartorius muscle.

ing to Bichat, of the *superior*, *middle*, and *inferior musculo-cutaneous*.

The *superior musculo-cutaneous* (called also *external ilio-inguinal*, *ilio-hypogastric*, *ilio-scrotal*) comes from the superior part of the plexus, passes outwardly through the psoas magnus to the quadratus lumborum, and thence to the back part of the crest of the ilium,—here it divides into an *external* and *internal* branch. The former supplies the abdominal muscles and integuments. The *internal* can be traced forward to the anterior superior spinous process of the ilium, and thence across parallel with Poupart's ligament to near the rectus, where it perforates the external oblique, and becomes cutaneous upon the pubic and inguinal regions.

The *middle musculo-cutaneous*, or *inguino-cutaneous*, has nearly a similar origin and distribution with the last.

The *inferior musculo-cutaneous*, or *external cutaneous*, comes from the first or second lumbar, passes along the iliacus muscle, and between the anterior superior and anterior inferior spinous processes, divides into an *anterior* and *posterior branch*. The former perforating the fascia lata about three or four inches below Poupart's ligament, becomes cutaneous, distributing filaments as low as the knee. The *posterior* is spent on the outer and back part of the thigh, either passing through or behind the tensor vaginæ femoris.

The *genito crural* comes from the second or third lumbar nerve. The *genital* or *spermatic* branch joins the cord at the internal ring, supplies the cremaster, and terminates upon the integuments of the scrotum and pubis, and in the female upon the labium. The *crural* goes beneath Poupart's ligament, pierces the sheath of the femoral vessels, sending some filaments in company with the artery, passes through the fascia lata, and supplies the integuments upon the front of the thigh as far as its middle.

The *terminal* branches of the lumbar plexus are the *anterior crural*, *obturator*, and *lumbo-sacral*.

The *anterior crural* (or *femoral nerve*) comes from the

superior lumbar nerves, and is the largest nerve of the lumbar plexus. It passes behind, and sometimes through the psoas muscle, and descends to Poupart's ligament, beneath which it passes about half an inch to the outside of the femoral artery, where it divides into numerous muscular and cutaneous branches. In the pelvis it distributes filaments to the psoas and iliac muscles.

The *obturator nerve* comes from the third or fourth lumbar, passes through the psoas muscle, and descends along the inner edge of the latter to the obturator foramen, through which it passes to the inner side of the thigh, where it divides into an *anterior* and *posterior* branch, which supply the muscles chiefly on the inner thigh, the adductors, gracilis, vastus internus, &c., as well as the integuments, and anastomoses with the vaginal branches of the crural; one long branch is traced as low down as the popiteal space, to the back part of the knee joint.

The *lumbo-sacral* nerve comes from the fourth and fifth lumbar, and descends into the pelvis to join the sacral plexus.

The *posterior* divisions of the lumbar nerves pass backward between the transverse processes, and supply the multifidus spinæ, longissimus dorsi, and sacro-lumbalis muscles, and the integuments. Varieties will be seen in the number and distribution of the branches of the lumbar plexus.

The *sacral nerves* (Fig. 204) consist of six pair. They divide within the spinal canal into anterior and posterior branches, which pass out at the anterior and posterior sacral foramina. The *posterior* are quite small, and supply the muscles and integuments on the back of the sacrum.

The *anterior* are large, the four superior of which, with the last lumbar uniting together, constitute the *sacral plexus*. These nerves all receive branches from the sacral ganglia of the sympathetic. The fifth and sixth are very small, sometimes absent, and escape between the sacrum and coccyx

The *sacral* or *sciatic* plexus is situated upon the side of

the rectum, in front of the pyriformis muscle, and behind the pelvic fascia. Its branches are divided into *internal* and *external.* The former are distributed to the pelvic viscera, the latter, consisting of the *greater* and *lesser ischiatic, gluteal,* and *pudic,* go principally to the lower extremity. All of these will be noticed in connection with the organs they severally supply.

CHAPTER V.

ACTIVE ORGANS OF THE TRUNK.

FOURTH DIVISION.

THE ORGANS OF URINATION.

THESE organs consist of the Kidneys, the Ureters, and the Bladder.

SECTION I.

THE KIDNEYS.

The kidneys are two firm, solid bodies, *situated* in the lumbar regions, at their posterior portion, extending between the crest of the ilium and the last rib—lying upon the psoas magnus, quadratus lumborum, and diaphragm, and corresponding to the two last dorsal, and two upper lumbar vertebræ.

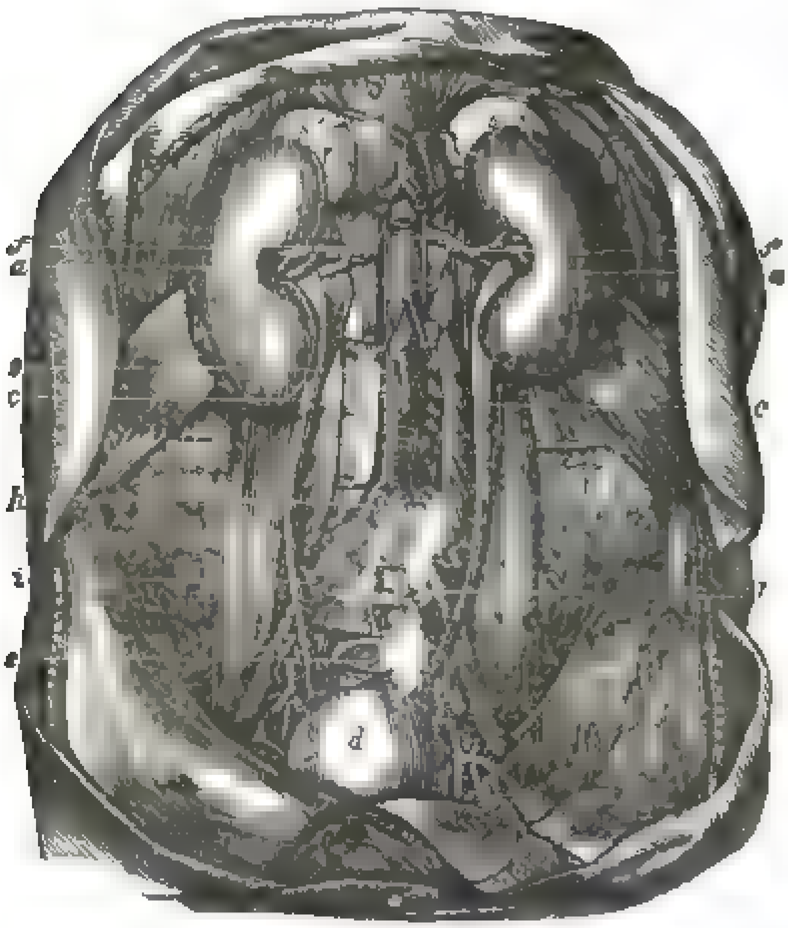
Their *form* is that of the kidney-bean. Their *size* is about four inches in length, and two in width. Their average weight is estimated at from three to four ounces. Their *color* is a dark, brownish red.

The anterior surface of each kidney is convex, the right having the ascending colon and duodenum upon it; the left the descending colon, and both of them the peritoneum upon this same surface. The posterior surface is flat. In the fœtus both surfaces present the lobulated appearance. The outer margin is smooth and convex; the inner presents a notch, *hilus renalis,* where the vessels and nerves enter and pass out. The upper end of each kidney is larger,

rounder, and nearer the spine, than the lower end, and is also surmounted by the renal capsule.

The kidneys are seen to vary in number, sometimes there being only one, which is quite large, and extending across the spine. The two kidneys are sometimes connected by a transverse band, and Dr. Horner cites an instance where one of the kidneys was in the pelvis in front of the rectum.

FIG. 205.



The kidneys are essentially glandular organs, and each consists of membranes, two distinct substances, the cortical and tubular, the excretory ducts, blood-vessels and nerves.

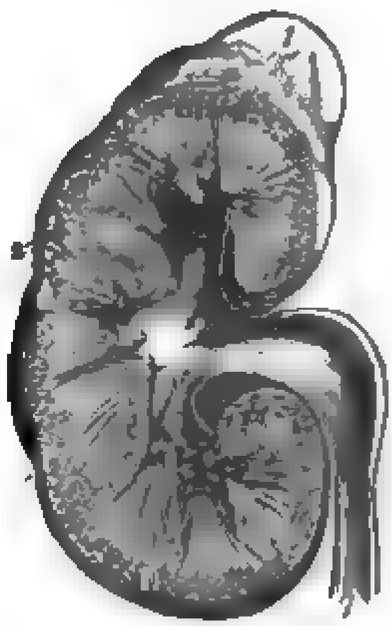
Three membranes are given to the kidney, a serous, cellulo-adipose, and fibrous. The first comes from the peritoneum, and is partial, covering only the anterior surface. Of the *second,* or *cellulo-adipose,* the cellular portion prevails in the young, while the adipose is most abundant in the adult. The *third* or *fibrous* is the proper coat of the kidney. It forms a capsule which completely envelops the surfaces, and enters the hilus along with the blood-vessels. This membrane, as already stated, is fibrous, and is also strong, elastic, smooth, and semi-transparent. It adheres to the sur-

FIG. 205 represents the Urinary Apparatus. *a a* Kidneys. *b b* Capsulæ renalis. *c c* Ureters. *d* Bladder. *e* Rectum. *f* Renal arteries. *g* Aorta. *h* Its division into the iliacs. *i* Point where ureters cross the iliacs.

face of the kidney by delicate cellular and vascular filaments, which are easily torn on raising it, and which are traced into its substance. It preserves the form of the kidney.

On making a section of the kidney from its convex to its concave portion, two distinct substances are noticed, the *external* or *cortical*, and the *internal* or *tubular*. The *cortical* forms the superficial layer, is about two lines in thickness, though varying at different points, and sends processes towards the centre of the gland between the tubular portion, thus dividing the latter into as many separate parts assuming the form of distinct cones. Its color is a reddish brown, and it is also called vascular from the quantity of blood-vessels with which it is supplied.

Fig. 206.



On being torn, a number of granules are seen, which seem to compose the great body of the cortical portion, and are called the *corpora*, or *acini* of *Malpighi*. These acini exist in immense numbers, and are seen as very minute, round, red points, their diameter being about the tenth of a line. Their connection with arterial branches is compared to that of berries with their stems. Some, among whom is the distinguished Ruysch, regard the acini as consisting wholly of blood-vessels, while others view them as little glandular sacs for secreting the urine, around whose walls the blood-vessels are ramified, and from which arise the commencing uriniferous or excretory ducts.

According to Mr. Bowman, these acini are composed of capillary arteries coiled up in loops and closely compressed, so as to form vascular balls, which are enclosed in dilatations of the urinary tubes, forming capsules for each.

Fig. 206 represents a section of the right Kidney, having the renal capsule on its top. 1 Supra-renal capsule. 2 Cortical portion. 3 Medullary or tubular portion. 4 Calyces. 5 Infundibula. 6 Pelvis. 7 Ureter.

Each capsule is perforated by an artery called *vas inferens*, which goes to form this vascular ball, and from the interior of each there passes out through the capsule a small vein called *vas efferens*, which, with other veins of like kind, goes to the venus plexus surrounding the convoluted urinary tubes. Two systems of vessels are here described, first the *arterial capillary*, composing the acini of Malpighi within the urinary capsule, and second, the *venous capillary* on the outside of the capsule surrounding the urinary tubes, and constituting a plexus which is compared to the portal plexus of the liver. This plexus is believed by Mr. Bowman to secrete the urea, lithic acid, and other solid portions, while he assigns to the arterial plexus or acini, the separation of the water and soluble elements of the urine.

The *internal* or *tubular* portion, (Fig. 206,) called also *pyramides Malpighi*, consists of fine tubes collected in fasciculi, forming *cones*, of which there are about fifteen. These cones are of a dense structure and pale color, with their bases at the circumference, and their apices at the central cavity of the kidney. They are separated and surrounded by the cortical substance, constituting the several conoidal fasciculi so many distinct lobes, or miniature kidneys, which are distinctly marked upon the surface of the fœtal kidney. The apex of each cone is free, and forms a projection into the central cavity termed *papilla* or *mammary* process.

The papillæ are not so numerous as the cones, as two or more of the latter converge into one of the former. The papillæ are arranged into an anterior, middle, and posterior row; and each one presents several foramina, through which the urine passes from the tubuli uriniferi. Each cone or pyramid consists of a collection of these tubuli, which are more numerous at the base than at the apex, in consequence of their coming together as they approach the latter. They are compared to fine hairs, and are proven to be conductors of the urine, by making a section of them and squeezing the cortical portion, when drops of urine

are seen to ooze out. They are convoluted tubes, in the cortex, called the *tubes* of *Ferrein*, intertwining here with the venous and arterial capillaries, and ending either in loops or cœca; while in the pyramids or cones these tubes pursue a straight course.

The papillæ are surrounded by funnel-like formations of a fibro-mucous character, called *infundibula*. The papillæ are sometimes more numerous than the infundibula, in which case two or more of the former are found to one of the latter. The infundibula come together or run into each other so as to form three compartments—one in the middle, and one at each end of the kidney, which, from their cup-like form, are termed *calyces*, and these calyces, by their union, expand into the oval cavity, at the inner margin of the hilus, constituting the *pelvis* of the kidney.

The *arteries* of the kidneys are the renal or emulgent, and come from the aorta, at right angles. Each divides into six or more branches, which enter the fissure of the kidney, and then sub-divide into numerous minute vessels which go between the tubuli to the cortex, and form numerous inosculations, constituting a capillary net-work. The *veins* correspond to the arteries, though they are larger. They pass out of the kidney at the fissure, and go to the vena cava ascendens. The left renal vein is longer than the right, and passes in front of the aorta.

The *lymphatics* are described as numerous, and go to the lumbar glands.

The nerves come from the solar plexus, lesser splanchnic, and lumbar ganglia of the sympathetic, and are traced along with the arteries.

Renal Capsules, (*capsulæ renales.*)—These bodies are two in number, and are also called *supra-renal* or *atra-biliary* bodies. They are situated at the superior extremity of each kidney, being attached by cellular structure and blood-vessels. Their *form* is triangular, with the base concave, and resting upon the kidneys. Their *color* is of a yellowish brown, and their *size* is variable, being much larger in the fœtus than in the adult.

The *structure* of these bodies consists of a thick membrane of cellular tissue, which surrounds and forms their proper coat, and processes which are traced within, separating its several parts. In the centre a small triangular cavity is seen, containing, in the fœtus, a viscid reddish fluid; in the child, a yellow fluid; in the adult, a dark brown liquid; while, in old age, it is almost entirely empty.

This cavity is not always found, and by some is denied to exist at all, and when present is attributed either to the enlargement of a vein, decomposition, or laceration.

The *arteries* come from the renal, aorta, and phrenic.

The veins of the right go to the vena cava ascendens; those of the left enter the emulgent.

The *nerves* are from the renal and solar plexus. Each capsule is divided into lobes, and these again have been divided into lobules, having granules, which are found to be connected with the veins.

Function.—The use of the renal capsules is as yet unknown. In the fœtus, like the thymus and thyroid bodies, they are large, and are supposed to be connected with fœtal sanguification.

Function of the Kidneys.—The use of these glands, it is well known, is to secrete the urine; and the cortical portion of the kidney, which is exceedingly vascular, has been assigned as the especial part where the secretion occurs, while the tubular conveys the fluid down the conical fasciculi to the papillæ, through which it passes into the pelvis. The uriniferous tubes are lined by mucous membrane, and are found by Henle to contain epithelial cells, which, as in other glands, are regarded as the true secreting agents. When filled, they break and discharge into the tubuli uriniferi, others being formed from the nuclei of the extinct cells.

The urine is composed principally of water. It also contains *urea*, a substance highly charged with nitrogen, and also *lithic* or uric acid. In children *hippuric* acid is found instead of the lithic. *Lactic acid*, an *animal extractive*

substance, and various *salts*, as the phosphate and sulphate of lime, muriate of ammonia and soda, and salts of magnesia, are also found as constituents of the urine.

SECTION II.

THE URETERS.

The ureters, (Fig. 205,) one for each kidney, are the excretory ducts, and extend from the kidney to the bladder, conveying the urine from the former into the latter. They are about the *size* of a goose quill, and of an average length of eighteen inches. They commence in the pelvis of the kidney, and emerging at the fissure behind the vessels, take a course downward through the lumbar regions, upon the anterior surface of the psoas magnus, and behind the peritoneum, crossing the primitive iliac arteries to the pelvis, which they enter. Here they cross the internal iliacs and vasa deferentia, and proceed to the back part of the bladder, which they enter by passing very obliquely through its coats, and terminating about ten or twelve lines from the neck. In the female, the ureter is in relation with the Fallopian tubes and broad ligaments.

The ureters consist of two coats, an outer or fibrous, and an inner or mucous coat. The fibrous is composed of dense cellular tissue. The mucous is pale, without valves, and traced into the bladder.

These tubes are larger at their commencement and termination than in the middle. They are capable of great dilatation, as seen in cases of obstructed urine, and in the passage of large calculi to the bladder, in which conditions they exhibit the greatest sensibility.

SECTION III.

THE BLADDER, (VESICA URINARIA.)

The bladder is a musculo-membranous sac, *situated* mostly within the pelvis, behind the pubis, and in front of the rectum. It is the largest of all the reservoirs of secretion, and receives the urine from the ureters.

Its position and capacity vary according as it is full or empty, and also according to age, sex, habit and disease. When empty, in the adult, it is contracted and found below and behind the pubes, and presents a flat, triangular shape. When moderately distended, it rises above the pubis, in contact with the recti muscles, and in front of the peritoneum, and assumes the form of an ovoid, the larger end being below upon the rectum, the smaller end above; when completely full, it rises still higher, enlarging more and more, and having its larger end above and the smaller below. In the fœtus it is relatively larger than in the adult. In the female it is larger than in the male, and the habit of retaining the urine renders it larger than when the calls of nature are promptly attended to. In disease every variety of size and the highest and lowest positions are seen.

The *form* of the bladder has been stated to be ovoid or egg-shape, but presenting differences according to causes above mentioned. Its *direction* or long axis is oblique from above downward and backward, and this obliquity, which varies with its distention, will correspond to a line extending from between the umbilicus and pubis to the coccyx. Its *divisions* are into a *body* or central portion, an upper or *superior fundus*, a lower or *inferior fundus* or base, and a *cervix* or neck. It is retained in its position by *ligaments*, which are divided into the false and the true. The false are formed by reflections of the peritoneum, and are two *posterior* and two *lateral*. The *posterior* extend one on either side, in a semilunar form, from the front of the rectum to the back part of the bladder, and contain the obliterated

Fig. 207.

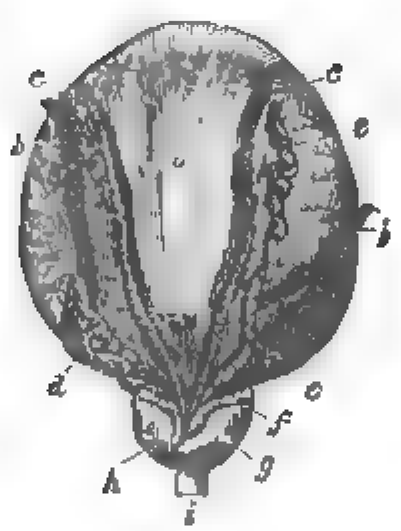


Fig. 207 represents the Urinary Bladder and its appendages. *a* Muscular structure of the Bladder. *b b* Ureters. *c c* Vasa deferentia. *d* Vesiculæ seminales. *f* Efferent duct of vesiculæ seminales. *g* Ductus ejaculatorius. *h* Prostate gland. *i* Membranous portion of urethra.

umbilical arteries and ureters. The two *lateral ligaments* extend from the iliac fossæ to the sides of the bladder, and contain the vasa-deferentia of the male, and the round ligaments of the uterus in the female.

This portion of the peritoneum, it is important to observe, descends upon the front and the sides of the rectum, to about four inches from the anus, leaving consequently the lower portion of the rectum uncovered by peritoneum. From this point it is reflected forward upon the bladder, at its lower and posterior part, a short distance above the base of the prostate gland, and about the middle of the vesiculæ seminales, whence it passes upward upon the back and sides of this organ to its superior fundus, and is then traced onward to the abdominal muscles, as explained elsewhere. It is just below the line of reflection, and on the inferior fundus of the bladder, that the latter organ can be entered from the rectum without injuring the peritoneum.

The *true ligaments* are *two anterior* and *two lateral*, to which are added the two *obliterated umbilical* arteries, and the *urachus*, making seven in all.

The *two anterior* come from the pelvic fascia, which lines the parietes of the pelvis, and is a continuation of the fascia iliaca. They commence at the lower portion of the inner surface of the pubis, on each side of the symphysis, and proceed upward to the front of the bladder, upon which they expand, as well as upon the upper surface of the prostate. The two *lateral ligaments* are also continuations of the pelvic fascia from the levatores ani muscles upon the sides of the bladder and prostate gland. The *umbilical* ligaments constitute the solid fibrous cords, which in the fœtus were the hypogastric arteries, and are found upon each side of the fundus of the bladder going to the umbilicus. The *urachus* is attached to the superior extremity of the bladder, and goes as a small fibrous cord to the umbilicus. In the fœtus it is seen as a tubular canal, though, according to Cruveilhier, it is always solid in both fœtus and adult.

Upon the external surface of the bladder, six regions

have been designated by anatomists: 1. The *superior*, in contact with the recti muscles, and with the small intestines, when the bladder is distended, and attached to which are the urachus and obliterated umbilical arteries; 2 and 3. The *lateral* regions, corresponding to the sides of the pelvis; 4. The *posterior region*, in relation with the rectum in the male, and the uterus in the female; 5. The *anterior region* behind the pubis and recti muscles, deprived of the peritoneum; and 6. The *inferior region*, resting upon the vesiculæ seminales and prostate, and in relation with the rectum in the male, and, in the female, contiguous to the vagina.

Structure.—The bladder is composed of four coats, the *peritoneal*, *muscular*, *cellular*, and *mucous*. The *peritoneal* or *serous* coat is only partial, covering simply the posterior part and sides of the bladder, extending from the summit to within an inch of the base of the prostate, whence it is reflected upon the rectum, forming the pouch which is seen between these organs. The *muscular coat* is arranged into fasciculi of pale fibres running in various directions, having spaces between them through which the mucous membrane sometimes protrudes so as to form pouches in which calculi occasionally lodge, and are not detected.

The muscular fibres are seen to run *longitudinally* and *circularly*, and some again present a reticular arrangement. The *longitudinal* are regarded as the most numerous and strongest. They commence about the cervix and are traced upward, expanding over the anterior surface of the bladder to its summit, and thence descending upon the posterior surface and sides, back to the neck, where, according to Wilson, they are inserted into a ring of elastic tissue, as pointed out by Sir A. Cooper surrounding the beginning of the urethra, and into the isthmus of the prostate. The *anterior fibres* are traced into the pubes and rami of the ischia, to which they are attached by four tendons, two on each side, a superior and inferior. This muscular coat receives the name of the *detrusor urinæ*.

The longitudinal fibres in the female, according to Mr.

Harrison, are "inserted anteriorly and laterally into the cellulo-vascular and glandular tissue around the cervix, and posteriorly into a more dense tissue connecting the urethra to the vagina."

The circular fibres are found to be scattered, pale, and indistinct on the upper portions of the bladder, while on the lower and about the neck they become more distinct and close, and form what is considered by some a distinct muscle, called the *sphincter vesicæ.* There are a variety of opinions in reference to this sphincter muscle; some, with Mr. Guthrie, asserting that there are no fibres around the neck of the bladder capable of forming a sphincter, while others, as Mr. Bell, Harrison, and Horner, distinctly describe them.

Sir Charles Bell represents a plane of muscular fibres, forming a semicircular band, about an inch in breadth, surrounding the lower half of the orifice of the urethra, and at this point especially strong, and dispersing into the substance of the bladder; while the upper half of the orifice is surrounded by a weaker set of fibres, though continuous with the lower, thus completing the sphincter.

Horner speaks of a similar muscular band on the lower semi-circumference of the neck of the bladder, the fibres of which, however, he finds not to run into the ordinary muscular structure of the bladder, but to go transversely and be connected with the lateral lobes of the prostate; while the superior semi-circumference presents a broad, thin, muscular layer, which is lost in the muscular structure of the bladder.

Beneath the mucous membrane of the vesical triangle, this same anatomist describes a muscular structure of the same extent and shape as the triangle itself. The anterior angle he traces to the posterior part of the caput gallinaginis. Between the two ureters, says Mr. Harrison, the circular or transverse fibres are very distinct, and a semilunar band forms the base of the trigone. Muscular fibres are also traced around and upon the ureters.

The third set of muscular fibres, from their honey-comb

appearance and the various directions they run, are called the *reticular*. Some of these fasciculi are found to be quite large, and from their projections and resemblance to the columnæ carneæ, have been called the *columnar bladder*. This arrangement produces pouches or depressions for the lodgment of calculi.

The *cellular* or *fibrous coat* is between the muscular and the mucous, and consists of fibres very compact, dense, strong, elastic; extensible, difficult to tear, forming a strong bond of union between the muscular and mucous coats, and impervious to water.

The fourth coat of the bladder is the *inner* or *mucous*, called also the villous coat. Its color is rather pale, or of a reddish white, and, in the contracted state, presents many folds or wrinkles, which are effaced when distended. It abounds with small mucous follicles, and is smoother than the same membrane in the stomach.

Several points are noticed on the inner surface of this coat. First, is a small triangular space, below and behind the neck of the bladder, known as the *vesical triangle*, (*trigone vesical*.) This space forms an equilateral triangle, about an inch in length, included between the orifice of the urethra and those of the ureters. The openings for the ureters form the posterior angles, while that of the urethra forms the anterior. Mr. Bell traces a muscular bundle of fibres, forming the lateral margins of the triangle, and proceeding from the ureters to the mouth of the urethra, designed he thinks to open the ureters and allow the free entrance of the urine. This triangular space is smooth, destitute of the wrinkles common to other parts of the bladder, and is very vascular and sensitive. By the aid of the lens numerous villi are detected.

At the mouth of the urethra, or anterior angle of the trigone, an eminence is observed, called the *uvula vesicæ*. This is situated about opposite the third lobe of the prostate, and is formed by a projection of the mucous membrane, which occasionally becomes an obstacle to the introduction of the catheter.

The *arteries* of the bladder vary in their origin, number, and size. They come from the internal iliac, pudic, and obturator.

The *veins* form around the cervix a plexus, which discharges into the internal iliac vein or some of its branches.

The *nerves* come from the hypogastric plexus, consisting both of ganglionic and spinal filaments, which explains the fact of the bladder being both a voluntary and involuntary organ.

Function.—The use of the bladder is essentially that of a reservoir for the urine; and by its muscular apparatus it is the chief agent of expelling the urine, as in paralysis of the bladder no action of the abdominal muscles can effect the expulsion.

CHAPTER VI.

THE ORGANS OF THE TRUNK.

FIFTH DIVISION.

ORGANS OF THE PELVIS.

This division comprises the organs of the pelvis, including the *male* and *female* organs of *generation.*

SECTION I.

THE MALE ORGANS OF GENERATION.

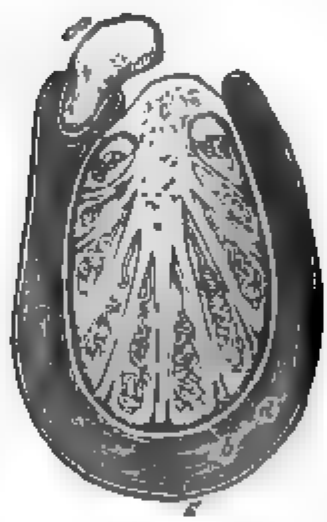
These organs comprise the *testes*, and their appendages, the *vasa deferentia*, the *vesiculæ seminales*, the *prostate gland*, and the *penis*.

The *testes* are two oval glands, suspended rather obliquely and having the sides compressed. The right is higher than the left. Each is surrounded by several coats, the *scrotum*, *tunica vaginalis*, *tunica albuginea*, and *tunica vasculosa.*

The *scrotum* is a double membrane. The outer consists of the common integument, and is distinguished by being very thin, of a dark color, and so transparent that the subcu-

taneous veins and follicles are seen through it. Hairs, running obliquely, thinly cover it, and it is usually wrinkled.

Fig. 208.



This coat is common to both testes, and is divided into two lateral portions by a median line common to the perineum and under surface of the penis, called the *raphe.* The next coat, or proper coat of the scrotum, is the *dartos.*

The *dartos* is a peculiar membrane, being regarded as a structure between the cellular and muscular, and consisting of a contractile fibrous tissue. It is attached to the rami of the pubes and ischium, and along the mesial line, where it is found most dense; it is reflected upward between the testes, constituting the *septum scroti.* It presents a reddish appearance, from the quantity of blood-vessels present; is always destitute of fat, and has its fibres running in every direction, though but loosely connected together. Its powers of contraction are well marked, as seen in the corrugation of the skin from the application of cold, and hence by some it is considered muscular.

The dartos, by some anatomists, is regarded as an expansion of the *gubernaculum testis;* but as it is found in the integument of the scrotum before the descent of the testes, it is justly considered by others as entirely independent of this structure. Beneath the dartos are the fibres of the cremaster muscle, which gives but a partial covering to the testicle, and receives the name of *tunica erythroides.*

Next in order is a condensed cellular membrane, which surrounds each testicle and its chord, connecting the cremaster and dartos with the tunica vaginalis, and called the *tunica vaginalis communis.*

The *tunica vaginalis* is a serous membrane, derived from

Fig. 208 represents a transverse section of the Testicle. *a* Cavity of the tunica vaginalis testis. *b* Tunica albuginea. *c* Corpus Highmorianum. *d* Tunica vasculosa. *e* One of the lobules with its seminal tubes. *f* Section of epididymus.

the peritoneum, during the descent of the testes from the abdomen into the scrotum. After the descent of the testes into the scrotum, the canal for its passage becomes closed, and this, like all serous membranes, presents the form of a shut sac. One portion of it lines the inner surface of the dartos, and is called the *parietal;* the other is reflected upon the forepart and sides of the testicle, and is the *visceral* or *tunica vaginalis testis.* Between the two portions is the smooth surface and cavity in which the secretion occurs. This membrane is loosely attached to the scrotum and epididymis, but firmly to the testis, or rather to the next membrane, the tunica albuginea.

The *tunica albuginea* forms the proper coat of the testis, is in direct contact with the gland, consists of a dense fibrous structure, of a bluish white color, and serves to preserve the organ in its proper shape. From its union with the tunica vaginalis, it is called a fibro-serous membrane, such as the pericardium and dura mater. After investing the testis, it is inflected at the posterior part, into the interior of the gland, by a vertical partition consisting of two laminæ, called the *mediastinum testis,* or *corpus Highmorianum,* between which are found the vessels, nerves, and ducts. Fibrous cords radiate, in great numbers, from this mediastinum to the inner surface of the tunic, and are called *trabeculæ septulæ.*

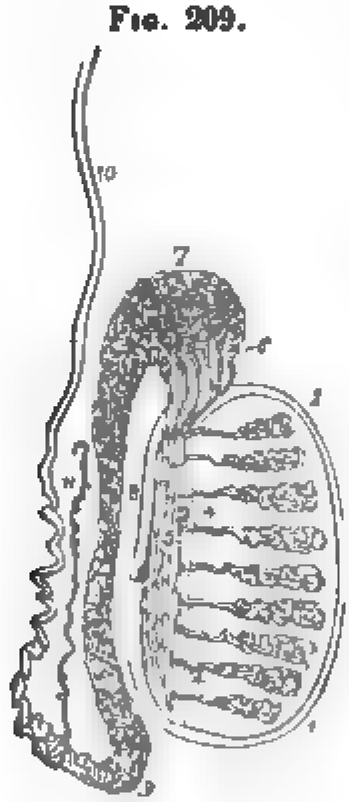
The *tunica vasculosa,* so named by Sir Astley Cooper, lines the interior of the albuginea, and is regarded as the nutrient membrane of the testis, bearing the same relation to the latter, that the pia-mater does to the brain. It is a very delicate membrane, consisting of a cellular web, containing the minute ramifications of the spermatic vessels, dipping into the substance of the gland, and sending processes between the several lobules.

On dividing the tunica albuginea, the proper substance of the gland is seen presenting a soft, grayish, or yellowish appearance, consisting of numerous delicate threads, loosely connected together, and which may be drawn out, for two or more feet, without breaking. These are the *tubuli semini-*

feri, and are in coils or convolutions. Being collected in bundles or *fasciculi*, they are termed *lobules*, of which latter there are estimated between three and four hundred, having a length, according to Dr. Monroe, of about 5208 feet. The diameter of each tube is made to measure from the 1-200 to the 1-150 part of an inch, and the length of each about 17 feet. Their commencement is either in loops of anastomosis or cœcal terminations, which communicate, though the tubes of one lobule are said not to inosculate directly with those of another.

The lobules present a conical form, having their bases towards the surface, and their apices towards the mediastinum testis, consisting of one or many convoluted tubuli seminiferi, and are enclosed and separated by processes from the tunica albuginea and vasculosa. The tubuli seminiferi of the lobules coalesce in about twenty or thirty straight tubes, called *vasa recta*, which, entering the mediastinum and interlacing here with each other and with the vessels and nerves of the gland, receive the name of *rete testis.* The rete testis is situated at the posterior part of the gland, and, at its upper part, passes through the tunica albuginea, by from ten to thirty tubes, called *vasa efferentia*, each of which, becoming convoluted, receives the name of *conus vasculosus*. From the bases of these coni vasculosi, larger tubes are formed, constituting the epididymis.

FIG. 209.



The *epididymis* is situated upon the outside of the tunica albuginea, upon the back of the testis, being connected to the latter by the reflected tunica vaginalis, and taking a vertical direction. It is formed of the

FIG. 209 represents the minute structure of the Testicle. 1 1 Tunica albuginea. 2 2 Corpus Highmorianum. 3 3 Tubuli seminiferi. 4 4 Vasa recta. 5 Rete testis. 6 Vasa-efferentia. 7 Coni-vasculosi, or globus major. 8 Epididymis. 9 Globus minor. 10 Vas-deferens. 11 Vasculum aberrans.

convoluted coni vasculosi, presenting an arched form, the larger end of which is above, and called the *globus major;* the lower end is the globus minor, while the intermediate portion constitutes the body.

The epididymis can be unraveled into a single convoluted tube, having an estimated measure of twenty-one feet, and receiving at intervals of about three inches the coni vasculosi. At the lower part of the epididymis this tube is less convoluted, and ends in the *vas deferens*, the excretory duct of the testicle.

The *vas deferens* is a large tube of cartilaginous density, proceeding from the globus minor to the vesiculæ seminales, and designed to conduct the semen into the latter from the testis. It ascends parallel with the epididymis, and above the head of the latter becomes one of the constituents of the spermatic cord, along the back part of which it ascends to the internal abdominal ring; here it leaves the vessels of the cord, and dipping into the pelvis, is enclosed in the lateral fold of the peritoneum, along which it proceeds to the side and inferior fundus of the bladder, where it converges towards its fellow on the inside of the vesiculæ seminales, at the angle of their junction, and at the base of the prostate each *vas deferens* joins the corresponding duct of the vesiculæ seminalis, forming the *ductus ejaculatorius*, which passes through the prostate, and opens into the urethra near the neck of the bladder on the side of the caput gallinaginis.

The vas deferens consists of two coats, an external, which is thick, hard, and firm, and regarded as fibrous; the internal is thin, pale, and mucous.

Just before the commencement of the vas deferens, a second tube is seen to leave the epididymis and run for a short distance parallel with the vas deferens, which it either joins or ends in a cul-de-sac. It is called *vasculum aberrans* (or blind duct) *of Haller*.

The *spermatic cord* consists of the vas deferens just described, the spermatic artery and veins, nerves, and lymphatics covered by cellular membrane, and the cremaster

muscle. It extends from the epididymis to the internal abdominal ring, and is covered by the remains of the peritoneum, which accompanied the descent of the testis, called the *tunica-vaginalis* of the cord.

The *spermatic artery* comes from the abdominal aorta, sometimes from the renal artery, proceeds along the psoas muscle to the internal abdominal ring; here it joins the spermatic cord, and descends along with it to the back part of the testicle, where it enters the rete testis by dividing into several branches, which again subdivide very minutely around the tubuli seminiferi. A branch goes to the vas deferens from the superior vesical called *deferential*, and one to the cremaster muscle from the epigastric, the *cremasteric* artery.

The veins, on leaving the rete testis, become very tortuous, twine round the arteries and form a plexus called the *corpus pampiniforme*, constituting the principal bulk of the cord. The right spermatic vein ends in the inferior cava near the renal. The left ends in the left renal vein.

The *nerves* come from the spermatic plexus. Branches also from the lumbar plexus go to the cremaster.

The *lymphatics* go to the lumbar glands.

The testes are not seen first in the scrotum, but are situated in the abdominal cavity, immediately beneath the kidneys and behind the peritoneum. They are represented as being about two lines long in the middle of the third month of uterine life. About the fifth or sixth month they have descended as low as the inferior portion of the psoas muscles. In the seventh month they are seen in the iliac fossa; in the eighth in the abdominal canal; and a few weeks before birth they are found to reach the scrotum. The *gubernaculum testis* is a cord composed of cellular and ligamentous fibres, extending from the inferior portion of the testicle to the scrotum, and is regarded as the agent by the contractile power of which the testis descends or is drawn into the scrotum.

Function of the Testes.—The office of these glands has been already stated to be to secrete the semen, a fluid

which, according to the microscope, contains numerous little filamentary bodies termed *spermatozoæ* or *seminal animalcules*, and granules, which constitute the elements of the reproductive cells, by which the germs for the continuance of the human species are provided.

The *Vesiculæ Seminales*, (Fig. 207.) These bodies are two in number, and *situated* on the under surface of the bladder behind and above the prostate, and in front of the rectum. They diverge behind, and converge in front, where they are separated only by the vasa deferentia. They are attached to the bladder by cellular tissue, and are surrounded by a venous plexus. The *form* of each is oval, having a length of about two inches, and a breadth of half an inch. They present the appearance of cells, but are found to consist of one continuous convoluted tube, the several coils communicating, and being connected by cellular tissue. Each vesicula has two coats, an *external* of fibro-cellular substance, and an *internal* or mucous. Each vesicle has an excretory duct about a line and a half long, which, uniting in the substance of the prostate with the vas deferens, forms a common duct, the *ductus ejaculatorius*, which is about three quarters of an inch long, passing forward through the prostate, and opening into the urethra on the anterior edge of the caput gallinaginis. These bodies communicate freely with the vas deferens, and are considered as reservoirs for the semen, but they are found also to contain a fluid of their own secretion, consisting of mucus of a yellowish brown color and viscid consistence.

Prostate Gland, (Fig. 207.)—This body is *situated* upon the neck of the bladder, and about an inch on the urethra. In shape and size it resembles a horse-chestnut. It is behind the triangular ligament, and in front of the rectum, to which it is attached by cellular structure. Its base looks backward, and its apex forward towards the urethra. It is about an inch in length, and half an inch in thickness. It is fixed by the anterior ligaments of the bladder to the symphysis of the pubis, and by the posterior layer of the triangular ligament, consti-

tuting a strong fascia, which invests the sides and inferior surface of this gland, thus forming for it a capsule.

Its *density* is firm and resisting. Its *color* is of a grayish hue. The posterior surface is flat and notched, which divides it into two lateral lobes, and on raising the vesiculæ seminales, a transverse process is observed connecting the lateral lobes, called by *Sir Everard Home* the third or *middle* lobe of the prostate. The sides of the prostate are round, smooth, and covered by the levatores ani muscles, veins, and a strong fascia. The *structure* of this gland consists of mucous follicles, which discharge by ten or more excretory ducts into the urethra on either side of the caput gallinaginis, and these follicles are surrounded by a condensed fibrous or cellular tissue. The fluid of this gland is white or brownish, and viscid.

THE PENIS.

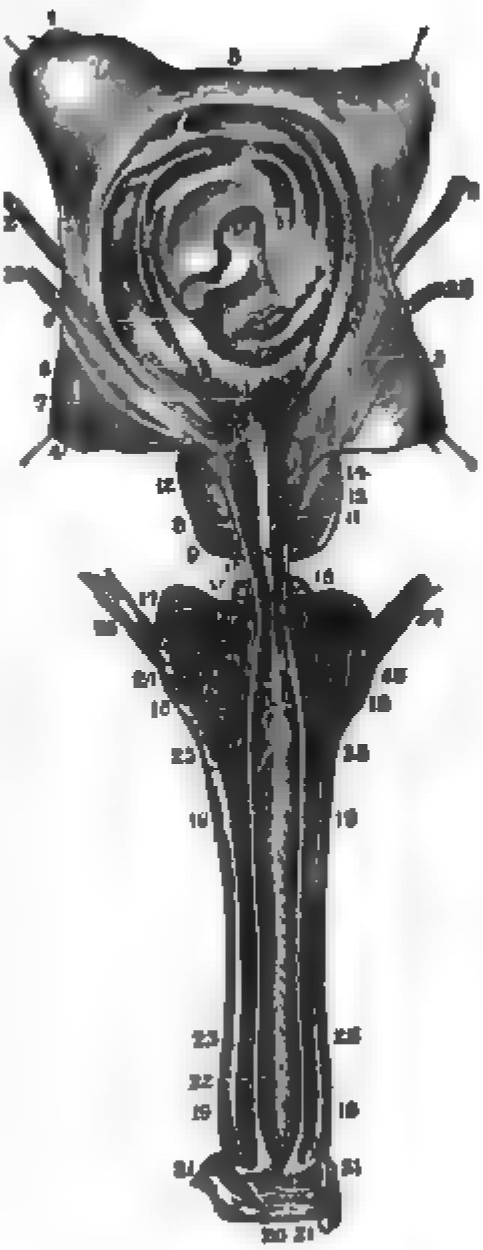
The penis is *connected* to the symphysis pubis, and in front of it. It is *divided* into a root, body, and extremity. The root is attached by two crura to the rami of the ischium and pubis. The body forms the intermediate or central portion, while the extremity consists of the glans penis.

Structure.—The penis consists of integument, cellular tissue, the corpora cavernosa, corpus spongiosum, and urethra.

The *integument* is delicate, thin, loose, and free from fat. It projects beyond the extremity of the glans, so as to form a loose sheath termed the *prepuce.* It is then reflected back to the root of the glans, thence over the glans itself, where it is very delicate, and is traced to the opening of the urethra continuous with the lining membrane of this canal. The prepuce is connected to the glans by a longitudinal fold or process called *frenum preputii.* Its inner layer is mucous and is connected to the outer by loose cellular tissue, which readily allows the infiltration of serum. Around the corona of the glans, and beneath the skin, numerous sebaceous glands are seen, called *glandulæ odoriferæ* or glands of Tyson.

The *cellular* coat is occasionally found much condensed, and lost in the fascia of the thighs. It is described as being reflected from the linea alba, upon the penis, as far as its extremity, being particularly strong where the penis is connected with the pubis, and constituting its *suspensory ligament.* This ligament consists of dense, fibrous tissue, in which elastic fibres have been detected, and it is supposed some muscular fibres have also been seen.

FIG. 210.



The *corpora cavernosa* form the largest portion of the penis, and consist of two semi-cylindrical bodies of considerable length, placed side by side, and having a partition between them, though rather imperfect, termed *septum pectiniforme.* The corpora cavernosa arise by two conical crura from the rami of the ischia and pubis, beginning in front of the tuber ischii, and proceeding to the lower part of the symphysis, where they unite to form the body; upon the extremity of which is situated the glans penis. The two corpora, representing two cylinders placed side by side, present be-

FIG. 210 represents the Penis and Bladder laid open. 1 1 Bladder. 2 2 Ureters. 3 3 Vesical orifices. 4 Uvula vesicæ. 5 Superior fundus of bladder. 6 Bas-fond of bladder. 7 Centre of vesicle triangle 8 Caput gallinaginis or verumontanum. 9 Opening of the ductus ejaculatorius 10 Depression near the caput. 11 Ducts from prostate gland. 12 13 Lateral lobes of the prostate. 14 Urethra, its prostatic portion. 15 Membranous portion. 16 Cowper's glands. 17 Point of entrance of their excretory ducts. 18 Bulb of urethra laid open 19 Section of corpora cavernosa. 20 Glans penis divided. 21 Prepuce taken off. 22 Internal portion of urethra laid open. 23 Exterior portion of corpora cavernosa. 24 25 Accelerator-urinæ muscle. 26 27 Erecto-penis.

tween them two grooves, the one superior, occupied by the dorsal vessels and nerves; the other, inferior, containing the urethra. Each corpus consists of a white, very strong, fibrous, and elastic membrane, consisting mostly of longitudinal fasciculi closely interlacing each other, though an internal layer of circular fibres, as continuous with the septum, is also seen. From the inferior groove, a number of radiating fibrous bands are seen crossing the cavities of the corpora to be inserted in the inner walls of this fibrous tunic; these cords are called *trabeculæ*, and are believed to strengthen the organ as well as to limit its distension. The interior of each corpus is occupied by a soft, cellulo-vascular, or erectile tissue, presenting a spongy appearance, or a multitude of cells, all of which communicate freely with each other and with the veins, and consist, says Dr. Morton, of an intertexture of veins closely woven together, so as to present the appearance of cells, which veins or venous plexuses are supported and separated by the trabeculæ.

The *corpus spongiosum* surrounds the urethra, and extends from between the crura about an inch behind their junction to the extremity of the penis. Its posterior extremity is called the *bulb*—its anterior the *glans penis*. The base of the glans presents a projection or shoulder, termed the *corona glandis*, and behind this is noticed a contraction called the neck.

The structure of the corpus spongiosum resembles the cavernosum, except that its external aponeurotic coat is much thinner, and its interior spongy erectile tissue much finer and more delicate. There is no direct communication between the corpora cavernosa and spongiosum, though a fine injection from the pudic artery will occasionally succeed in injecting both at the same time.

The urethra (Fig. 210) is a membranous canal *situated* along the inferior groove of the corpora cavernosa, and extending from the neck of the bladder to the extremity of the penis. The *course* of this canal from the neck of the bladder is first forward and downward, covered by the prostate gland, and called the *prostatic portion*. It then

proceeds to the symphysis pubis, beneath which it makes a slight curve, having the concavity upward.

This portion is called the *membranous*, while the balance, commencing at the bulb and going to the extremity of the glans, receives the name of the *spongy* portion.

The *length* of the urethra varies according to the erection of the penis, averaging from seven to nine inches. To the prostatic portion is given about an inch and a half, and to the membranous about an inch. The urethra is composed of two coats, an outer fibrous and elastic, and varying in strength and density at different points, being stronger in the prostatic and membranous portions than in the spongy; and the inner or mucous coat which is smooth and thin, and continuous with the mucous coat of the bladder posteriorly, and the integument of the glans anteriorly, also with the lining membrane of the excretory ducts of Cowper's glands, the prostate, the ejaculatory ducts, and the several lacunæ.

The *prostatic* portion is considered the widest part of the canal; on its lower surface the mucous coat presents a longitudinal fold along the mesial line, called *caput gallinaginis* or *verumontanum.* On each side of the caput gallinaginis a fossa is seen, called *prostatic sinus*, in which the ducts of the prostate open. At the anterior extremity of the caput the common ejaculatory ducts are found to terminate, and between the latter, an opening looking backward into a small dilated sac, is noticed, called *sinus pocularis.* The caput gallinaginis is regarded in the light of a valve to prevent the escape of urine in the contracted state of the urethra; but during the action of the detrusor urinæ, the caput is drawn down and the elastic ring expanded so as to permit the escape of the urine. The *membranous* portion is the narrowest part of the canal, and is surrounded by an elastic and erectile reddish tissue, and the deep layer of the triangular ligament, with the compressores urethræ muscles. It lies between the prostate and bulb. In the latter the urethra again enlarges, and then again in the spongy portion, which is the longest of the three, becomes smaller till

it approaches the glans, where it becomes so large as to receive the name of *fossa navicularis*. The mucous coat is very sensitive, and so numerous and superficial are its veins, as to bleed freely, often, on introducing the catheter. The urethra abounds with mucous lacunæ, especially upon its upper wall, which discharge their secretions into this canal; their orifices present forward, and are believed sometimes to interrupt the course of the catheter. One of these, about an inch and a half, from the meatus is named the *lacuna magna*.

Cowper's Glands.—These are two bodies about the size of peas *situated* behind the bulb, and covered by the accelerätores urinæ muscles. They are of a yellowish color, hard, and sometimes not found. They each discharge into the urethra in front of the bulb by an excretory duct which runs forward for about an inch.

The *arteries* of the penis come from the terminal branches of the internal pudic. The *internal pudic* arises from the *internal iliac*, forming one of its terminating branches; sometimes it comes from the *ischiatic*, along with which it leaves the pelvis below the pyriform muscle, returns again between the sacro-sciatic ligaments, and then ascends along the inner side of the tuber and ramus of the ischium and pubis, to a short distance below the symphysis, where it ends in two branches. In this course, besides supplying branches to the bladder, rectum, vesiculæ seminales, prostate, and to the vagina in the female, it sends off opposite the ramus of the ischium the *artery* of the *bulb*, which passes between the triangular ligament, and is distributed through the corpus spongiosum as far as the glans.

The terminating branches of the internal pudic are the *arteria dorsalis penis* and *arteria corporis cavernosi*. The former goes between the crura upon the dorsum of the penis as far as the prepuce, which it supplies, also forming a circle around the corona glandis, and anastomosing with branches in the glans of the corpus spongiosum. The *artery* of the *corpus cavernosum* enters the crus, and runs along the septum, giving off branches as it proceeds.

Muller speaks of arteries which he calls *arteriæ helecinæ*,

coming off from the pudic, and going to the venous cells in tufts. The existence of these, however, is denied by other anatomists.

The *veins* are numerous and large, and supplied with valves. They are divided into the *superficial* and *deep*. The former begin in the prepuce, form the two dorsal veins of the penis, which go to the root of the penis, receiving branches in their course, and then pass beneath the arch of the pubis to join the plexuses of the bladder and prostate gland. The *deep veins* accompany the pudic artery and its branches, and join the internal iliac.

The *nerves* of the penis come from the internal pudic, which has its origin from the lower part of the sacral plexus. The internal pudic nerve takes a similar course with the internal pudic artery, along the inner surface of the tuber and ramus of the ischium, covered by the obturator fascia, and towards the pubis it divides into a *superior* and *inferior* branch. The superior nerve accompanies the arteria dorsalis to the glans of the penis, which it supplies. It sends off at the root of the penis a branch which enters the corpus cavernosum, also a cutaneous branch, supplying the integument and prepuce. The *dorsal nerve* in the glands of the penis is observed to expand, and assume a reddish, ganglionic appearance, sending off delicate filaments, which are traced to the very sensitive membrane covering the glans.

The *inferior* branch of the pudic supplies the bulb and corpus spongiosum, the scrotum, muscles and integuments of the perineum, and the anus. Branches of the sympathetic are also traced to the penis.

SECTION II.

THE FEMALE ORGANS OF GENERATION.

These comprise the *external* and the *internal organs* of generation.

The *external* organs of generation include the

Mons veneris,	Labia majora,	Labia minora,
Clitoris,	Meatus urinarius,	Orifice of the vagina.

The term *vulva* is applied, by some anatomists, to all these parts; while others restrict this term simply to the fissure or urino-sexual opening between the labia majora.

The *mons veneris* is the prominence *situated* on the front and upper part of the pubis. It is composed chiefly of cellular tissue, abounding with adipose matter, and, in the adult, is covered with hair.

The *labia majora*, or *externa*, are two longitudinal folds of integument, situated upon either side, and extending from the mons veneris in front, to their common junction behind, in a crescentic edge or commissure called the *fourchette*. Between this latter and the vagina a depression is observed, termed the *fossa navicularis*.

Between the fourchette and the anus, a distance of about an inch, is the *perineum*. The *labia*, like the mons veneris, consist of loose cellular tissue and fatty matter, and constitute the anterior boundary of the sexual organs. The external surface is covered with hair, the internal is a mucous membrane, covered with a smooth, delicate epithelium, and containing numerous sebaceous follicles. The use of these labia seems to be, to favor the expulsion of the child, as during parturition they are found completely unfolded.

The *labia minora*, or *interna*, called also *nymphæ*, are *situated* within the greater labia, and consist of two smaller folds of mucous membrane, which descend and are lost upon each side of the vaginal orifice. They are also covered by a fine epithelium, have many sebaceous follicles, and enclose an erectile tissue. They are broad before, narrow behind, proportionally more developed than the greater labia in the infant, and sometimes found very much enlarged and elongated from hypertrophy. In parturition they are also unfolded, and disappear.

The *clitoris* is *situated* directly below the symphysis pubis, and is compared to the male penis. It presents a small red prominence, constituting a body, which is formed by the union of the crura, arising from the rami of the pubis and

ischium, and joining opposite the symphysis; to which they are connected by a suspensory ligament. The body is from half an inch to an inch long, rather curved, looks downward from between the anterior commissure of the labia, and from having some resemblance in its extremity to the glans penis, is called the *glans clitoridis*. The clitoris is covered by a fold of the mucous membrane, derived from the upper part of the nymphæ, and called *præputium clitoridis*. In structure the clitoris resembles the corpora cavernosa penis, in having an exterior fibrous sheath, and an interior spongy, erectile tissue. It is also supplied in pretty much the same manner with blood-vessels and nerves, as the penis, but, unlike the latter, is imperforate, and not concerned in conducting the urine from the bladder. There is also an erector muscle to this body, like the erector penis, which will be described under the head of perineum. The clitoris, like the nymphæ, is large in the infant, and has been seen elongated to the extent of one or two inches.

The *meatus urinarius* is situated about an inch below the clitoris, immediately above the vagina, and is always readily detected by the presence of a small tubercle surrounding it. This orifice is found in the small triangular depression between the clitoris and vagina, called *vestibulum*, and is the external opening of the urethra.

The *female urethra* is about an inch and a half long, proceeds backward and upward upon the upper surface of the vagina, with which it is very strongly connected, passes beneath the symphysis pubis, to which it is also attached by the anterior ligaments of the bladder, and after forming a slight curve, goes to terminate in the neck. This canal is larger and more dilatable than the male urethra. It consists of a mucous coat, continuous with that of the bladder, of a red color, having longitudinal folds, with numerous mucous follicles, and of an external coat of condensed cellular tissue, which is also elastic, erectile, and muscular in its nature.

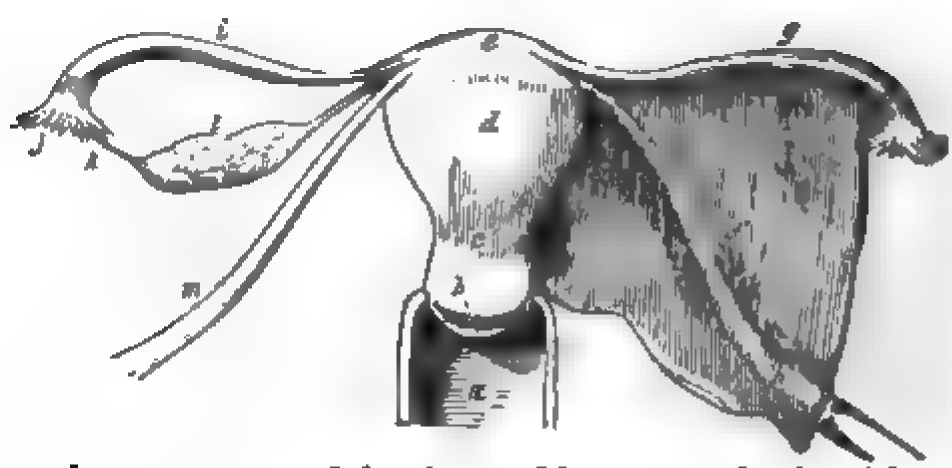
The *orifice of the vagina* is directly below the meatus urinarius, and is bounded laterally by the nymphæ. Its *form*

is oval, and presents a projecting, and somewhat thickened and corrugated margin. It is generally closed by a fold of the mucous membrane, called *hymen*. This hymen forms a septum which presents a variety of forms; sometimes it is circular, with an opening in the centre and a fringed edge, sometimes semilunar with an opening in front, sometimes a transverse septum with two openings, then again a complete septum without any opening, in which case the menstrual secretion is confined, a condition which is attended with some danger; and then again the hymen may be entirely wanting. When ruptured, its margin presents from two to six or more fringe-like processes or tubercles, termed *carunculæ myrti-formes*.

The internal organs of generation include the *vagina*, the *uterus*, the *ovaries*, and the *Fallopian tubes*.

The *vagina* is a membranous canal leading from the

FIG. 211.



vulva to the uterus, and is *situated* between the bladder and rectum. Its *direction* is upward and backward. It is about six or seven inches in length, and in the axis of the outlet of the lower pelvis, forming an angle with the uterus, and being somewhat concave in front and convex behind. Its anterior and posterior surfaces are flattened and in contact, the anterior being the shorter of the two. Its anterior extremity is smaller, and presents its greatest diameter

FIG. 211 represents the female internal Organs of Generation. *a* Upper portion of vagina. *b* Os-uteri. *c* Cervix uteri. *d* Body of the uterus. *e* Fundus. *f* Broad ligament. *g i* Fallopian tube. *h* Round ligament. *j* Fimbriated extremity of Fallopian tube. *k* Its connection with the ovary. *l* Ovary. *m* Round ligament.

vertically; while the posterior or uterine is the larger, and has its greatest diameter transversely.

The vagina surrounds and is prolonged for a short distance upon the uterus, presenting a circular depression. It is *connected* in front to the bladder very closely, by means of a reddish structure resembling the dartos; and has, at this point, an inseparable attachment to the urethra. Behind, the peritoneum is attached to its upper third, while the lower is connected to the rectum by a loose dartoid tissue; upon its sides are seen the levatores ani, the pelvic fascia, and the broad folds of the peritoneum.

The *structure* of the vagina consists of three membranes, a *mucous*, *erectile*, and *fibrous*.

The *mucous*, or internal coat, is continuous with that upon the labia, and presents about the vulva a vermillion tinge, while, at its uterine portion, it is seen of a marbled or grayish hue. It presents numerous transverse rugæ, which are not unfolded, but form a roughened surface most distinct on the upper part. Along the median line of each surface a prominent ridge is observed, called the *columns* of the vagina.

This coat abounds with mucous follicles and papillæ, and is covered by a distinct squamous epithelium.

The *erectile* or middle coat, called also *plexus retiformis* from the abundance of its veins, consists of a spongy tissue, and is compared to the corpus spongiosum urethræ. It is enclosed between two fibrous laminæ, and is found in the greatest quantity about the anterior extremity of the vagina. The *sphincter vaginæ* muscle covers this middle coat.

The *external* coat is fibrous, consisting of condensed cellular structure, is very elastic, and resembles the dartos.

On each side, near the middle of the orifice of the vagina, and beneath the sphincter muscle, is seen a mucous gland about the size of a pea, which is compared to Cowper's glands. Their excretory ducts open in front of the carunculæ myrtiformes.

The *uterus* is situated between the bladder and the rec-

tum, in the cavity of the pelvis. Its *form* is triangular or pyriform. Its *size* varies; the average dimensions being about three inches in length, two in breadth at the superior portion, and one inch in thickness, in the unimpregnated state. Its *divisions* are into the *fundus*, *body*, and *neck*.

The *fundus* is the superior portion between the Fallopian tubes; the *neck* is the inferior, cylindrical, and constricted part; while the intermediate portion constitutes the *body*.

The *direction* of the uterus is downward and backward, corresponding to the axis of the superior strait, and forms an angle with the vagina which runs forward and downward, in the axis of the lower strait.

The uterus has its *anterior surface* flattened and covered in its upper half by peritoneum, which is reflected upon the bladder, forming the anterior or vesico-uterine ligament. The *posterior surface* is convex, being entirely covered by peritoneum, which is reflected upon the rectum, forming the posterior or *recto-uterine ligaments*. The sides have the *broad*, *round*, *ovarian* ligaments, and the *Fallopian tubes* attached to them.

The *broad ligaments* are two folds of the peritoneum, extending from the uterus to the sides of the pelvis, and thus dividing the cavity of the latter by a transverse septum, separating the bladder from the rectum. The *round ligaments* are situated in front and below the Fallopian tubes, in the anterior fold of the broad ligaments. They ascend to the internal ring, through which they pass, being surrounded at this point by a sheath from the peritoneum, called the canal of Nuck; thence they descend the inguinal canal, and pass out the external ring to be lost in the mons veneris. These ligaments consist of condensed cellular or fibrous tissue, with numerous blood-vessels and nerves from the spermatic plexus; muscular fibres have also been seen entering into their composition. Their *function* is to retain the uterus in its natural position.

The *ovarian ligaments*, about two inches in length, extend from the superior and lateral angles of the uterus, below and behind the Fallopian tubes, within the posterior fold

of the broad ligaments, to the ovaries. They are regarded as fibro-muscular, and serve to fix the ovaries. The *superior extremity* or fundus of the uterus is convex, and presents upward and forward behind the bladder, and, in the undistended state, below the brim of the pelvis. The inferior extremity or cervix looks downward and backward, and is surrounded by the vagina, into which it projects. It presents the *os-tincæ* or *uteri*, which in the virgin is a circular opening, with smooth borders, but in the female who has borne children, it is more projecting, larger, slightly wrinkled, and more transverse, being divided into an anterior and posterior lip. The anterior or superior is thicker than the posterior or inferior, which is longer.

The uterus, when opened, presents a triangular cavity, the base of the triangle being above, and having at each angle the small funnel-shaped orifice of the Fallopian tube. The sides of the triangle are curvilinear, and the inferior angle forms the os-uteri, which is seen in the vagina. This cavity has been found deficient. The cavity of the neck is cylindrical and flattened, and smaller at either end than in the middle.

Structure.—The uterus is composed of an *external* or *serous* coat, an *internal* or *mucous*, and an *intermediate tissue*, called the *proper fibrous* or *fibro-muscular*, with blood-vessels and nerves.

The *serous* coat and its ligaments have been already described. The *mucous* coat is a thin, smooth, delicate membrane, lining the internal cavity, of a pale color, becoming brighter during menstruation, and covered by an epithelium, columnar and ciliated. In the neck it presents, along the middle, longitudinal lines or columns, from which transverse rugæ or folds are observed to pass, and which, from their arborescent appearance, receive the name of *arbor-vitæ*. Between these folds are found many mucous follicles, whose mouths, from irritation or any other cause, becoming obliterated, present the form of small spherical sacs, from the accumulation of their secretions, which Naboth mistook for eggs or rudiments of the

fœtus, and were called *ovula Nabothi*. This coat is more vascular in the body than in the neck, and is so delicate and difficult of demonstration that some have even denied its existence. The *middle coat* or *proper tissue* is composed of strong, grayish fibres, closely interwoven, and, in the unimpregnated state, presenting the density of cartilage under the knife. The true character of these fibres is yet unsettled, some contending that they are muscular, others that they are fibrous, while others regard them as fibrous in the unimpregnated, and muscular in the pregnant organ. This latter opinion seems to correspond with the changes observed in the uterus before and after pregnancy.

In the former or quiescent state, the uterus, as stated, is condensed and compacted in its fibres—hard, without contractility, and presenting very little the appearance of muscular tissue; while during gestation the blood-vessels become greatly enlarged, the sensibility much exalted, and the fibres softened, loose, immensely contractile, as proven by the state of labor, and exhibiting, in an eminent degree, all the characteristics of muscles of organic life.

In this state of gestation the fibres are seen to be arranged into two layers, a *superficial* and *deep*—the former longitudinal upon the anterior and posterior surface of the body, oblique upon the sides and fundus, and continued upon the Fallopian tubes, round, and ovarian ligaments. The deep layer is seen to consist of two series of conical fibres, the base being in the body of the uterus, and the apex at the Fallopian tubes. Around the neck the fibres are circular, intersecting each other at different angles.

Of the *arteries* of the uterus, two, the *uterine*, come from the internal iliac, and two, the *spermatic*, from the aorta. The *uterine veins* are very large, and during pregnancy are called *sinuses*; they discharge into the internal iliac and renal veins, and the vena cava.

The *nerves*, during pregnancy, are also large and well developed; they come from the hypogastric and renal plexuses, with some of the anterior branches of the sacral nerves. The *lymphatics* of the uterus, in gestation, are, like the veins, very large.

Function.—The uterus receives and retains the ovum during the whole period of gestation, from a short time after conception, to birth; and is also the prime agent in the expulsion of the child.

THE OVARIES.

The *ovaries* (testes muliebres, Fig. 211,) are two small, flattened, oval bodies, one on each side of the pelvis, *situated* in the posterior fold of the broad ligament, and connected to the uterus by means of the broad and round ligaments. These bodies are of a pale color, about an inch in length, and about an inch and a half distant from the uterus. Both the situation and size, however, depend upon age and pregnancy. In the fœtus, like the testes, they occupy the lumbar regions, whence they gradually descend into the pelvis. During pregnancy they ascend into the abdomen along with the uterus, and after parturition, for a short time, they are found in the iliac fossa. They are proportionally larger in the fœtus than in the adult, are found to lessen in size after birth, to enlarge again at puberty, and then to diminish and become wasted in old age.

Structure.—Each ovary is composed of an outer coat, which is serous and derived from the peritoneum—a middle, which resembles the tunica albuginea of the testes, and is a white, strong, fibrous capsule, sending prolongations into the interior of the gland, which divide it into irregular partitions, like the interlacing of areolar tissue. Lining this fibrous coat is seen a vascular one, which also goes into the interior, and assists in forming the areolar or cellular tissue.

This latter tissue is the *stroma* or spongy bed of authors, in which are deposited a number of small vesicles called the *Graafian vesicles.* Their average number is from ten to fifteen in the mature state, though the microscope reveals numerous others not yet arrived at maturity. Each of the Graafian vesicles is represented as a small, transparent cyst, varying in size from a pin's head to that of a

small pea, having thin, transparent walls, and enclosing a fluid, either colorless or yellow. This fluid is said to be albuminous, and to contain microscopic granules, and, at the least, one ovum. The walls of the vesicle are observed to consist of two coats, an external or vascular, regarded as simply the thickening of the surrounding *stroma*, and an internal coat, transparent, structureless, and lined with an epithelium, constituting the true ovisac.

The *ovum*, according to the microscope, is about the 1-120 of an inch in diameter, and is surrounded by a transparent membrane, containing the yolk, which seems to consist of granules or cells, and fat globules. In the yolk is also seen the *germinal vesicle* of *Purkinje*. This vesicle contains a transparent fluid, and has also within it the germinal spot of *Wagner*, called *macula germinativa*, about the 1-200 or 1-300 of a line in diameter. The granules of the ovum are arranged into a membraniform structure called *membrana granulosa.*

The *corpus luteum* is a yellowish or brownish spongy tissue, containing a small cavity, and is regarded as the remains of the ruptured Graafian vesicle after the escape of the ovum at impregnation. This cavity presents a puckered membrane lining it, the remains of the ovisac. In the recent state, the opening into this sac is distinct, but after parturition it becomes closed, leaving nothing but a cicatrix to indicate its position. But in time the cicatrix is known to be effaced, and even in a girl of only five years a corpus luteum has been seen, so that the absence of the cicatrices cannot be regarded as positive proof of virginity, nor the presence of corpora lutea as always indicating the state of impregnation.

The *blood-vessels* of the ovaries are the same as those supplying the testes—the spermatic.

Function.—The *use* of the ovaries seems to be to prepare the germ to be fecundated by the male semen. They are regarded as essential in the function of reproduction, since their extirpation is always followed by sterility.

The Fallopian Tubes, (Fig. 211.)—These tubes, named after their discoverer, are situated within the fold of the broad ligament, along its superior border. They are two in number, one on each side of the pelvis, and extend from the superior angles of the uterus, transversely to the distance of from four to five inches, where each terminates in a free and fringe-like extremity, called *corpus fimbriatum*, consisting of several irregular processes. In this course the tubes have the round ligaments in front, and the ovaria, with their ligaments, behind. The uterine extremity has a very small orifice, scarcely admitting a bristle, while the outer or ovarian end presents a trumpet-mouth as large as a quill, and, with its processes, receives the name of *morsus diaboli*. These processes or fimbriæ are in one or more rows, one of which attaches them to the ovary. The Fallopian tubes are straight at the inner end, but pursue a tortuous course in their outer portion.

Structure.—These tubes have three coats—an outer, loose, and serous, and derived from the broad ligaments; a middle, fibrous, or fibro-muscular coat, having longitudinal fibres externally, and circular internally, continuous with those of the uterus; and an internal or mucous coat, which is continuous internally with that of the uterus, and externally with the peritoneum, the only instance of direct continuity between a mucous and serous membrane. This mucous coat is thrown into longitudinal folds, admitting of dilatation, and is covered by an epithelium, both ciliated and columnar. Neither orifice of the Fallopian tube, nor any part of its course has any valve.

Function.—The use of these tubes is to transmit the fecundating principle of the male to the ovary, and to conduct to the uterus the ovum when fecundated. Their use is the same as the oviduct, and it is found that the ovum, in its passage along the Fallopian tube, receives a double envelope—an internal layer, of an albuminous or gelatinous nature, called the *amnion*, and an external fibrous layer, called the *chorion*. The time it takes the ovum to traverse

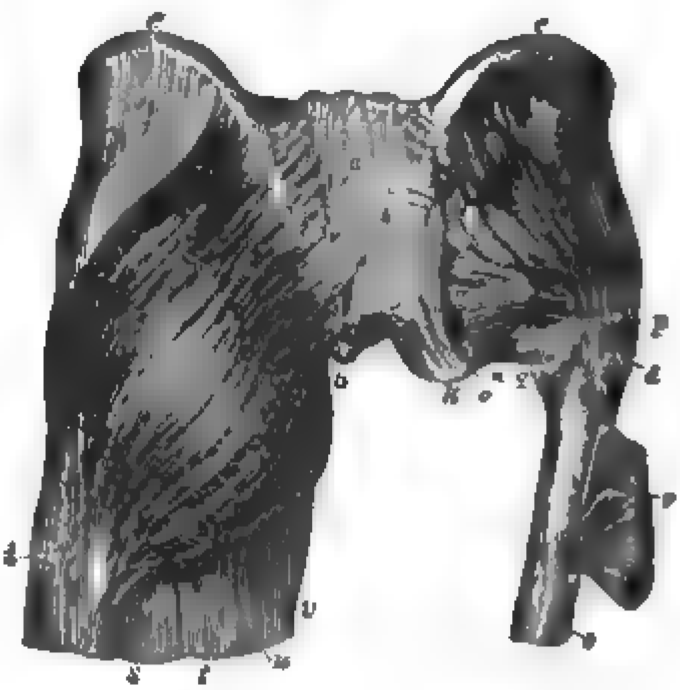
one of these tubes is estimated at from eight to fourteen days. The uterus has been preparing a membrane, the *decidua*, which lines its internal surface by the time the ovum arrives. That which covers the uterus is the *decidua vera;* that which covers the ovum, the *decidua reflexa.* The *placenta* is next seen, which is regarded as a joint production of both the ovum and the mother.

SECTION III.

MUSCLES OF THE PELVIS.

Gluteus maximus.—*Dissection.*—Make an incision round the crest of the ilium to the coccyx, extending downward upon the outer side of the thigh, about three or four inches; make another incision from the middle of the crest of the ilium to the trochanter major. Dissect off the integuments, adipose structure, and fascia, in the direction of the last incision, which is the course of the fibres of the muscle, and which will expose its whole extent.

FIG. 212.



It *arises* from the posterior part of the crest of the ilium from the contiguous dorsum of this bone, from the side of

FIG. 212 represents the Muscles of the Pelvis on its exterior. *a* Posterior surface of the sacrum. *b* Os-coccygis. *c* Crest of ilium. *d* Trochanter major. *e* Linea aspera. *f* Gluteus maximus. *g h* Gluteus medius. *i* Vastus externus. *j* Greater sacro-sciatic ligament. *k* Tuberosity of the ischium. *l* Pyriformis. *m* Gemellus superior. *o* Gemellus inferior. *n* Obturator internus. *p* Obturator externus. *q* Quadratus femoris. *r* Insertion of gluteus maximus. *s* Biceps femoris. *t* Semi-tendinosus. *u* Semi-membranosus. *v* Gracilis.

the sacrum and coccyx, and from the great sacro-sciatic ligament, by fleshy and aponeurotic fibres. Its fibres are collected into distinct fasciculi, presenting a thick, strong, and large quadrangular fleshy mass of muscle, of a rough and coarse appearance, descending obliquely downward and forward to terminate in a broad, thick tendon, which is *inserted* into the upper third of the linea aspera, also into a rough ridge, leading from this line to the trochanter, and into the fascia lata over the vastus externus. The fasciculi of this muscle are separated by processes of the fascia femoris, and it almost entirely covers all the muscles on the back of the pelvis together with the origin of the hamstring muscles. A large *bursa* is observed between the tendon and vastus externus, and a third where this muscle glides over the tuberosity of the ischium.

Function.—To extend the thigh and rotate it outward; also to support the trunk in the erect position.

Turn down the gluteus maximus upon the thigh, and we expose the gluteus medius, gluteus minimus, pyriformis, gemelli, obturator, and quadratus femoris.

The *gluteus medius* (Fig. 212) is a triangular, flat muscle, having its anterior portion uncovered by the gluteus maximus. It *arises* from the outer edge of the whole of crest of the ilium, except its posterior part, by fleshy and aponeurotic fibres; also from the dorsum of the ilium, between its crest and semicircular ridge, and from the strong fascia which covers it. It is *inserted* by a broad, thick tendon, into the upper and outer part of the trochanter major, and into a portion of the shaft of the bone.

Function.—To extend the thigh and turn it outward. A bursa is seen between the tendon of this muscle and the tendinous insertion of the rotators.

The *gluteus minimus*, (Fig. 212,) so named from being the smallest of the three glutei, is seen by raising the last. It *arises* from the dorsum of the ilium, between the semicircular ridge and the margin of the acetabulum, and ending in a round, strong tendon, is *inserted* into the upper, anterior portion of the trochanter major, having a bursa between

it and the insertion of the gluteus medius. *Function.*—The same as the last, and also to strengthen the ilio-femoral articulation.

The *pyriformis* (Fig. 212) is a triangular muscle, which *arises* by its base within the pelvis, fleshy and tendinous, from the second, third, and fourth divisions of the sacrum, and forms a thick, conical belly, which passes out at the upper part of the great sciatic notch, receiving fibres in its course, from the sciatic ligament and posterior inferior part of the ilium. It is *inserted* by a round tendon into the superior portion of the fossa at the root of the trochanter major. *Function.*—To rotate the thigh outward.

The *gemelli* (Fig. 212) are two small muscles. The *superior* arises from the spine of the ischium, the *inferior* from the tuber of the ischium and the great sciatic ligament. They run parallel to each other, and both are *inserted* into the root of the trochanter major.

Function.—To rotate the thigh outward, and strengthen the capsular ligament.

The *obturator internus* (Fig. 212) arises from the pelvic surface of the obturator ligament, except at the superior part where the obturator vessels and nerve pass out; also from the obturator margin and plane of the ischium. Its fibres converge to a flat tendon, which passes through the lesser sciatic foramen, and thence goes between the gemelli muscles to be *inserted* into the fossa at the root of the great trochanter. As this muscle passes over the ischium, there is found interposed a bursa, and another between the tendon and the gemelli.

Function.—To rotate the thigh outward.

Obturator Externus.—*Dissection.*—Most of the muscles on the anterior and internal thigh at the superior part must be removed, when this muscle will be seen to arise fleshy from the anterior surface of the obturator ligament, except where the obturator vessels pass out, and also from the surrounding margin of the thyroid foramen. The fibres converging, end in a tendon which passes outward and ackward in a groove behind the neck of the femur, to be

inserted into the lower part of the fossa, at the root of the great trochanter.

Function.—To rotate the thigh outward.

The *Quadratus Femoris* (Fig. 212) is situated lower down than the other rotators, and arises from the external surface of the tuber ischii fleshy and tendinous.

Its fibres run transversely, and are *inserted* fleshy and tendinous into the back part of the great trochanter and intertrochanteric line. A bursa is found between this muscle and the little trochanter.

Function.—To rotate the thigh outward.

The psoas muscles and iliacus internus are noticed in another place.

SECTION IV.

FASCIA OF THE PELVIS.

The *pelvic fascia* is regarded as a continuation of the iliac, which descends into the pelvis from the brim, to which it is attached, to about midway its depth, where it divides into two laminæ, the *superior pelvic aponeurosis* or *vesical fascia*, and the *lateral pelvic aponeurosis* or *obturator fascia.*

The *superior* or *vesical fascia* is seen by removing the peritoneum, when it will be found to line the inner surface of the levator ani muscle, and to assist in closing the pelvis, fixing its several viscera, and resisting pressure from the abdominal muscles. It is reflected from the inferior edge of the symphysis pubis upon the neck of the bladder and prostate gland, constituting the anterior true ligaments of the bladder. Upon this organ it is reflected laterally, forming its lateral ligaments. Posteriorly it becomes thin and cellular, and is lost upon the sacrum. Mr. Tyrrell notices a reflection of this fascia between the bladder and rectum, which he terms *recto-vesical.* Another process, the *rectal fascia*, descends, and covers the lower part of the rectum behind and laterally. This latter fascia, with the recto-vesical in front, forms a complete aponeurotic investment for the lower portion of the rectum.

The *obturator fascia* covers the obturator internus muscle, and is upon the outside of the levator ani. This fascia is connected with the great sciatic ligament, and the rami of the pubis and ischium, and is continuous with the triangular ligament. It forms a sheath for the pudic vessels and nerves, and sends off a process which covers the lower or perineal surface of the levator ani, called the *ischio rectal* or *anal* fascia.

Triangular Ligament, or *Ligament of Camper*, or *Deep Perineal Fascia.*—This ligament consists of a strong aponeurosis, forming a septum between the pelvis and perineum. It is *situated* below the symphysis pubis, attached to and filling up the space between the rami of the pubis and ischium. Its *shape* is triangular, the base being below and the apex above. It consists of two laminæ, one anterior, upon which the bulb rests, the other posterior, surrounding the membranous part of the urethra, and enclosing the prostate gland.

This ligament is penetrated by the urethra about an inch below the pubic arch. Between its two laminæ, at the inferior margin, and posterior to the bulb of the urethra, are seen Cowper's glands, already described. At the upper part of this ligament, between its layers, and immediately below the symphysis, about half an inch broad, thick and strong, and stretching from side to side of the rami of the pubis, is another called the *sub* or *inter-pubic* ligament. These ligaments help to form the anterior boundary of the pelvis, besides giving passage to the urethra, and supporting and fixing its bulb.

SECTION V.

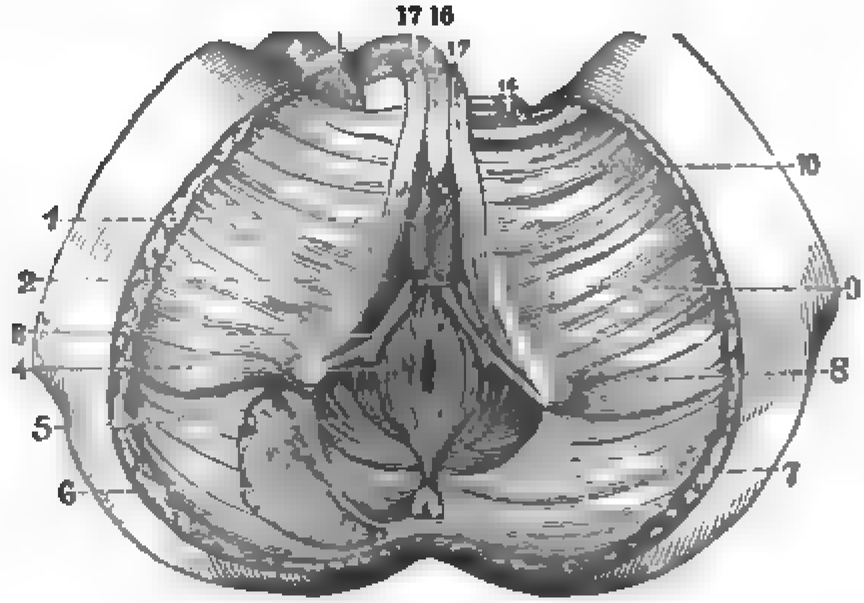
THE PERINEUM OF THE MALE.

The different elements composing the perineum consist of fascia, muscles, blood-vessels, and nerves.

Dissection.—The subject is placed as in the operation for lithotomy, that is, upon the back, with the thighs and knees bent upon the trunk, and the feet and hands bound together. The knees being thrown apart, and the scrotum

secured upward by means of the double tenaculum, an incision is made transversely along the base of the scrotum;

Fig. 213.



then two vertical incisions running from the extremities of the first, along the rami of the pubis and ischium, to a point corresponding to the apex of the coccyx. These two latter incisions, being united at their coccygeal end, will thus complete and describe the perineal space. This space has along its median line a prominent ridge termed the *raphe* of the perineum, which is found to extend along the scrotum and penis as far as the prepuce. The integument should first be dissected off.

The *fasciæ* of the perineum consist of the *superficial*, *middle*, and *deep*. The superficial is seen immediately on removing the integuments, and consists of condensed cellular tissue, continuous with that upon the inner side of the thigh, attached to the rami of the pubis and ischium, and about the anus containing a quantity of soft, granular, adipose matter. This fascia gives a covering to the muscles of the perineum; or more properly speaking, on being removed, is found to cover another fascia, which has been called the *middle*, and consists of a semi-transparent and

Fig. 213 represents the Muscles of the Male Perineum. 1 Accelerator urinæ. 2 Erector penis. 3 Transversus perinei. 4 Sphincter ani. 5 Levator ani. 6 Coccygeus. 7 Gluteus maximus. 8 Adductor tertius or magnus. 9 Adductor brevis. 10 Adductor primus or longus. 17 17 Corpora cavernosa. 16 Urethra. 14 Spermatic cord.

fine but dense aponeurosis, forming the immediate covering to the muscles. This, however, is sometimes called the *deep* fascia, though this latter term, to avoid confusion, has been restricted to another fascia still deeper, the *triangular ligament*, which has been already described.

The *muscles* of the *perineum* are seen on removing the fascia, and are ten in number, the—

Sphincter externus,	Transversus perinei,
Sphincter internus,	Coccygeus,
Erectores penis,	Levatores-ani.
Acceleratores urinæ,	

The *sphincter externus*, or *ani*, (Fig. 213,) is a cutaneous muscle, surrounding the anus, and presenting a flat, thin, pale, and elliptical plane of fibres. It has two fixed points of attachment—one to the os-coccygis and recto-coccygeal ligament behind, which is called its origin; the other to the central point of union of the perineal muscles in front, and also to the superficial fascia and raphe, which is the *insertion*. On surrounding the anus, it expands outward nearly to the tuberosities of the ischia.

Function.—To close the anus, and draw the bulb of the urethra back, or the coccyx forward.

Sphincter internus, or *orbicularis*.—This muscle surrounds the lower portion of the rectum, is in close contact with the mucous membrane, and is regarded simply as a continuation and thickening of the circular muscular coat of this intestine. *Function.*—To assist in closing the anus.

The *erector* or *compressor penis* (Fig. 213) *arises*, fleshy and tendinous, from the inner and anterior surface of the tuber ischii. Its fibres adhere to the rami of the ischium and pubis, and end in a tendinous expansion which is lost or *inserted* into the fibrous membrane of the corpus cavernosum or crura penis. This muscle is long and narrow.

Function.—To draw down and compress the penis, and thus aid in its erection by preventing the return of the blood, though its use, by some, is not considered as fully understood.

The *accelerator urinæ*, or *ejaculator seminis*, (Fig. 213,) is *situated* upon the back part of the corpus spongiosum urethræ and its bulb. It *arises*, along with its fellow, from the central line or raphe, forming a thin muscle upon the middle of the perineum, the fibres of which diverge like the feathers of a quill, the posterior covering the bulb, being *inserted* into the triangular ligament, and sometimes attached to the rami of the ischium and pubis. The middle fibres are short and surround the urethra; while the anterior are the longest and ascend upon the crura of the penis. *Function.*—To expel the semen and the last drops of urine.

The *transversalis perinei* (Fig. 213) *arises* from the tuberosity of the ischium at its inner side; the fibres run transversely and are *inserted* into the central point of the perineum, behind the acceleratores. This muscle is frequently indistinct and sometimes absent. *Function.*—To fix the bulb and dilate it.

A fasciculus of fibres, called *transversus perinei alter*, is sometimes seen in front of the transversalis, and is regarded as a portion of the accelerator urinæ, being *inserted* into the common central point and side of the bulb. Its *function* is the same as that of the transversalis.

The *coccygeus* (Fig. 213) is a small, triangular muscle, seen within the pelvis. It *arises* tendinous and fleshy from the spine of the ischium, and is *inserted* into the side of the coccyx and extremity of the sacrum.

Function.—To bring the coccyx forward, and to assist in closing the lower and posterior part of the pelvis.

The *levator ani* (Fig. 213) is a broad, thin muscle, forming a great part of the floor of the pelvis. It *arises* fleshy from the back part of the symphysis pubis, from the superior margin of the thyroid foramen; from the obturator fascia as it stretches in the form of a semilunar chord from the upper margin of the thyroid foramen towards the spine of the ischium; fleshy and tendinous from the spine and inner surface of the ischium. The fibres of this muscle converge and descend backward. Its anterior fibres, which

descend along the side of the lower fundus of the bladder, the membranous part of the urethra, and the prostate gland, are inserted into the central point of the perineum. The middle fibres are *inserted*, according to Dr. Horner, into the semicircumference of the rectum, between the longitudinal fibres of the latter and the circular fibres of the sphincter ani, while the posterior fibres are inserted into the os-coccygis and back part of the rectum.

Function.—To draw the rectum forward and assist in expelling the fæces, urine, and semen.

The *compressores* or *levatores urethra*, described by Mr. Wilson, and the *transverse compressors* of Mr. Guthrie, are regarded as nothing more than the anterior portions of the levator ani.

In the female perineum, the *erector clitoridis* muscle corresponds with the *erector penis*, and the *sphincter vaginæ*, with the *accelerator urinæ*.

Blood-vessels of the perineum.—The arteries come from the internal pudic, and consist of, 1. *Inferior hæmorrhoidal*, going to the side of rectum and anus. 2. *Superficial perineal.* 3. *Transverse perineal.* These two latter supply the perineal space and go to the scrotum. 4. *Artery of the bulb*, which passes between the layers of the triangular ligament and goes to the bulb and corpus spongiosum. The *veins* corresponding to the arteries terminate in the internal iliac vein.

Nerves of the Perineum.—These come from the *pudic nerve*, which arises from the lower part of the sacral plexus and takes the course of the internal pudic artery. The inferior branch of the pudic is the proper perineal nerve, and gives off the *external perineal*, *superficial perineal*, and *nerve of the bulb*.

SUMMARY OF MUSCLES, BLOOD-VESSELS, AND NERVES OF THE TRUNK.

Under the arrangement which we have adopted the muscles of the neck form a part of those belonging to the trunk. The order will be, 1. The neck, 2. The back, 3. Abdomen, 4. Chest, 5. Pelvis.

MUSCLES OF THE NECK.

To the neck proper are assigned 18 pair of muscles, arranged, agreeably to Mr. Harrison, into four groups, besides which there are five other groups, including twenty-one pairs and two single muscles; making in all thirty-nine pairs and two single muscles.

First Group—*Two pairs of Muscles.*

Platysma-myoides.
Sterno-cleido mastoideus.

Second Group—*Four pairs.*

Sterno-hyoideus.
Sterno-thyroideus.
Thyro-hyoideus.
Omo-hyoideus.

Third Group—*Five pairs.*

Digastricus.
Mylo-hyoideus.
Genio-hyoideus.
Hyo-glossus.
Genio-hyo-glossus.

Fourth Group—*Seven pairs.*

Longus colli.
Rectus capitis anticus major.
Rectus capitis anticus minor.
Rectus capitis lateralis.
Scalenus anticus.
Scalenus medius.
Scalenus posticus.

Fifth Group—*Three pairs.*

Stylo-hyoideus.
Stylo-glossus.
Stylo-pharyngeus.

Sixth Group—*Four pairs.*

Lingualis.
Superficial lingual.
Transverse lingual.
Vertical lingual.

These are the muscles proper of the tongue.

Seventh Group—*Three pairs.*

Constrictor pharyingis inferior.
Constrictor pharingis medius.
Constrictor pharyngis superior.

Muscles proper to the pharynx.

Eighth Group—*Four pairs and a single muscle.*

Levator palati.
Circumflexus, or tensor palati.
Constrictor isthmi-faucium, or palato-glossus.
Palato-pharyngeus.
Azygos-uvulæ, a single muscle.

Muscles proper of the palate.

Ninth Group—*Seven pairs and a single muscle.*

Crico-thyroideus.
Crico-arytenoideus posticus.
Crico-arytenoideus lateralis.
Thyro-arytenoideus.
Arytenoideus obliquus.
Arytenoideus transversus, a single muscle.
Aryteno-epiglottideus.
Thyro-epiglottideus.

Muscles proper of the larynx.

MUSCLES OF THE BACK, ARRANGED INTO SIX LAYERS.

FIRST LAYER—*Two pairs of Muscles.*
Trapezius.
Latissimus dorsi.

SECOND LAYER—*Three pairs.*
Levator anguli scapulæ.
Rhomboideus minor.
Rhomboideus major.

THIRD LAYER—*Four pairs.*
Serratus posticus superior.
Serratus posticus inferior.
Splenius capitis.
Splenius colli.

FOURTH LAYER—*Seven pairs.*
Sacro-lumbalis.
Longissimus dorsi.
Spinalis dorsi.
Cervicalis ascendens.
Transversalis colli.
Trachelo-mastoideus.
Complexus.

FIFTH LAYER—*Seven pairs.*
Rectus capitis posticus major.
Rectus capitis posticus minor.
Rectus capitis lateralis.
Obliquus capitis superior.
Obliquus capitis inferior.
Semi-spinalis dorsi.
Semi-spinalis colli.

SIXTH LAYER—*Five pairs.*
Multifidus spinæ.
Levatores costarum.
Supra-spinales.
Inter-spinales.
Inter-transversales.

MUSCLES OF THE ABDOMEN—SEVEN PAIRS.

Obliquus externus abdominis descendens.
Obliquus internus abdominis ascendens.
Transversalis.
Cremaster.
Rectus abdominis.
Pyramidalis.
Quadratus lumborum.

MUSCLES OF THE CHEST—FOUR PAIRS, PROPERLY SPEAKING.

Pectoralis major.
Pectoralis minor.
Subclavius.
Serratus major anticus.
Intercostales externi.
Intercostales interni.
Levatores costarum.
Triangularis sterni.
Diaphragm.

MUSCLES OF THE PELVIS.

THOSE OF THE INTERIOR ARE,
Psoas magnus.
Psoas parvus.
Iliacus internus.

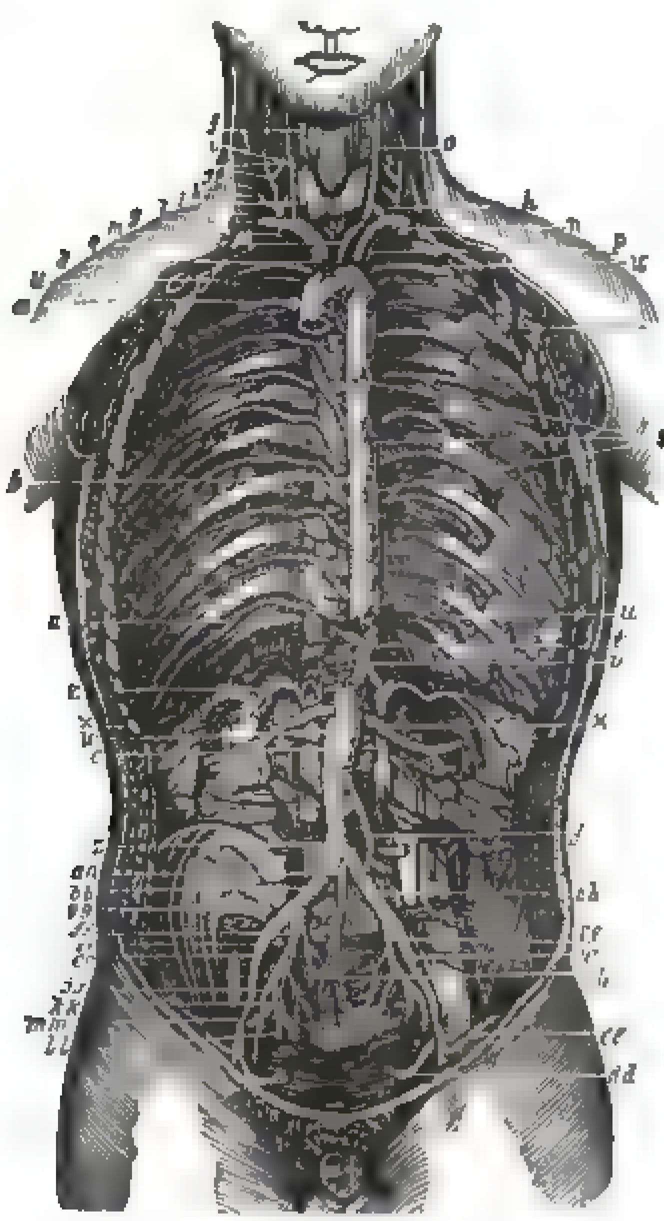
THOSE OF THE EXTERIOR ARE,
Gluteus maximus.
Gluteus medius.
Gluteus minimus.
Pyriformis.
Gemellus superior.
Gemellus inferior.
Quadratus femoris.
Obturator externus.
Obturator internus.

THOSE OF THE INFERIOR PELVIS ARE,
Sphincter ani.
Transversus perinei.
Accelerator urinæ.
Erector penis.
Levator ani.
Coccygeus.
Compressor urethræ.
Erector clitoridis.
Constrictor vaginæ.

BLOOD-VESSELS OF THE TRUNK.

For a brief summary of the blood-vessels of the trunk, we refer to the following figure, 214, and its explanation; and for further detail to figures 8, 9, and 120.

FIG. 214.



a Aorta, its commencement. *b* Thoracic aorta. *c* Abdominal aorta. *d* Arteria innominata. *e* Common carotid. *f* Superior thyroid artery. *g* Right subclavian. *h* Vertebral. *i* Inferior thyroid. *j* Anterior cervical. *k* Transverse cervical. *l* Superior scapular. *m* Superior intercostal. *n* Internal mammary. *o* Left carotid. *p* Left subclavian. *q* Mediastinal. *r* Upper intercostal arteries. *s* Œsophageal. *t* Phrenic. *u* Lower intercostal artery. *v* Cœliac, its division into the gastric, hepatic, and splenic arteries. *w* Superior mesenteric. *x* Emulgent. *y* Inferior mesenteric. *z* Aorta, its division into the primitive iliacs. *a a* Middle sacral. *b b* Common iliacs. *c c* External iliacs. *d d* Epigastric. *e e* Circumflexa ilii. *f f* Internal iliac. *g g* Ilio-lumbar. *h h* Lateral sacral. *i i* Gluteal. *j j* Vesical. *k k* Obturator. *l l* Ischiatic. *m m* Internal pudic.

NERVES OF THE TRUNK.

See figures 14, 152, 155, 203, 204, and 153, with their explanations.

SECTION VI.

ANATOMICAL AND PHYSIOLOGICAL RELATIONS OF THE MOUTH WITH THE DIFFERENT ORGANS OF THE TRUNK.

The several organs of the trunk comprise the *digestive*, *pulmonary*, *urinary*, and *generative.*

The mouth has a relation more or less intimate, both by structure and function, with all these various organs. With the digestive and pulmonary the relation is direct and inseparable. The same mucous membrane, for instance, which lines the mouth, is traced down the œsophagus into the stomach, and through the whole alimentary canal. It is continued also into the various excretory ducts of the salivary glands, liver, pancreas, and mucous follicles, all of which organs pour their several fluids into the mouth and digestive tube. This same mucous membrane is traced from the mouth, in another direction, into the larynx, trachea, bronchi, and lungs. The mucous membrane is also found in the kidneys, ureters, and bladder, the genital organs of the male and female, receiving here the name of the genito-urinary mucous membrane, which, however, is not directly traceable to the mouth.

The cellular tissue forms another element of anatomical continuity between the mouth and the various organs.

The *par-vagum*, one of the divisions of the eighth pair of nerves, forms a great chain of nervous connection between the posterior mouth, and the œsophagus, stomach, larynx, lungs, and brain. The fifth pair of nerves, which are mostly nerves of sensibility, bountifully supply all the organs of the mouth, and connect directly with the brain, spinal marrow, and the several organs of sense. The portio dura of the seventh pair, also forms an element of nervous communication between the mouth and other parts. The blood-vessels, supplying the mouth, come from the same great arterial tube which supplies all the organs of the body.

The physiological relation of the mouth with the various organs is as close as the anatomical.

The digestive function, for instance, comprises a series of sub-divisions or functions, constituting so many links or stages, each one of which is essentially related with, and dependent upon every other and the whole; and the whole upon each, for the completion and perfection of this wonderful and complicated process, styled digestion.

The function of digestion begins in the mouth by subjecting the crude material of nutrition to the several operations of mastication, insalivation, and deglutition, and the aliment having arrived in the stomach, the function is there continued, by converting this aliment into *chyme*, whence it is conducted into the small intestine, and there undergoes its final change, by being formed into *chyle*, and thus completing the whole process of digestion.

But the relation of the mouth, in this series of physiological actions, does not stop here; for we follow the chyle through the great trunk of the absorbent system, into the left subclavian vein, thence through the heart to the lungs, where, with the venous blood, and by atmospherical agency, it undergoes its final and most perfect change; in other words, is formed into *arterial blood*, the only and proper pabulum by which the mouth, as well as the whole body with all its organs, is built up and sustained.

To accomplish this result, we now trace this fluid blood from the lungs into the heart and arteries, by which latter it is distributed over the whole body, and consequently brought back to supply the mouth, the point where began the first change in this most beautiful series of operations so essential to the formation of this vital fluid.

These several relations, anatomical and physiological, thus briefly sketched, which the mouth has with the various organs, shows an intimacy of connection, not only close, but inseparable. Hence the dental student will perceive the absolute necessity of not confining his anatomical studies solely to the mouth, but of examining studiously every organ and portion of the body with which the mouth has any relation, as necessary steps to becoming completely master of his profession.

PART FOURTH.

THE LANGUAGE OF ANATOMY.

III. THE EXTREMITIES.

PART FOURTH.

THE LANGUAGE OF ANATOMY.

III. THE EXTREMITIES.

PART FOURTH.

THE LANGUAGE OF ANATOMY.

III. THE EXTREMITIES.

PART FOURTH.

SUPERIOR EXTREMITY.

THE SUPERIOR EXTREMITY COMPRISES BONES, LIGAMENTS, MUSCLES, FASCIÆ, BLOOD-VESSELS, AND NERVES, AND WILL BE EXAMINED UNDER THESE SEVERAL HEADS RESPECTIVELY.

CHAPTER I.

THE BONES.

The Bones are arranged into those of the Shoulder, Arm, Forearm, and Hand.

SECTION I.

BONES OF THE SHOULDER.

The bones of the shoulder are two in number: 1. The Scapula; 2. The Clavicle.

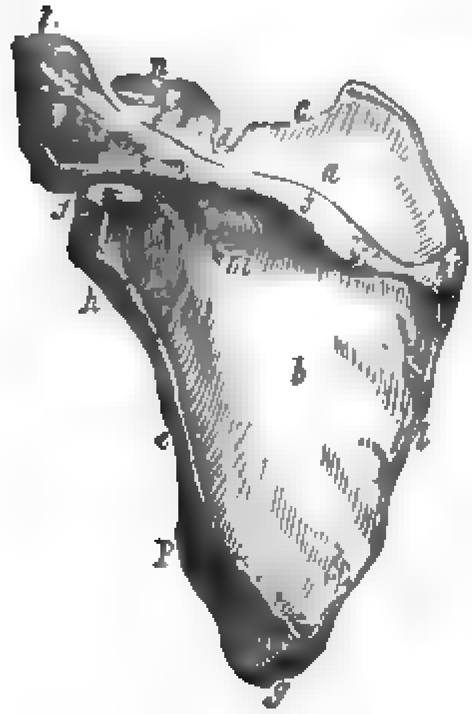
THE SCAPULA OR SHOULDER BLADE, (Fig. 215.)

The *Scapula* is *situated* upon the posterior and superior part of the chest. Its *form* is triangular, and it presents two surfaces, three edges, and three angles. The anterior surface looks toward the ribs, and is also the internal surface or subscapular fossa. It is concave, divided by several irregular lines, and occupied by the subscapular muscle. The posterior or external surface is the dorsum, and is cut transversely into two unequal parts by a very prominent process called the spine of the scapula.

This spine proceeds forward, and terminates in the *acromion* process, which is flattened superiorly and inferiorly, and overhangs the shoulder joint. This spine also divides the dorsum into the *supra* and *infra spinal fossæ*, which contain the supra and infra spinal muscles. The upper edge of the spine has the trapezius attached to it, the lower edge the deltoid muscle.

The *superior* edge or *costa* is *situated* between the anterior and superior angles, is thin and short, and has at its fore-part a notch, which is formed into a foramen by a ligament, and transmits the supra-scapular nerve. The omo-hyoid, supra-spinatus, and sub-scapular muscles are also attached to this edge.

Fig. 215.



At its anterior portion the *coracoid* process arises. This is long and narrow, runs upward and forward, and bounds the glenoid cavity internally. Its superior surface is rough for the attachment of ligaments, the inferior is smooth for the sub-scapular muscle. The extremity of this process frequently presents three distinct surfaces, the inner of which has the pectoralis minor inserted into it; the middle gives origin to the coraco-brachialis, and the outer to the short head of the biceps.

The *anterior* or *axillary* edge looks downward and backward, and extends from the anterior to the inferior angle. It is the thickest of the three edges, and gives attachment to the teres major, teres minor, and long head of the triceps. The *posterior* or *vertebral* edge, called also the *base*, extends from the superior to the inferior angle, and is the longest of the three margins. Below the spine are attached to it the rhomboideus major, opposite the origin of the spine the rhomboideus minor, above the spine the levator scapulæ, and along its whole extent the insertion of the serratus major anticus. At the junction of the superior costa and the base is the *superior* angle. At the

Fig. 215 represents the Scapula. *a* Supra-spinal fossa. *b* Infra-spinal fossa. *c* Superior edge or costa. *d* Coracoid notch. *e* Anterior or inferior edge. *f* Glenoid cavity. *g* Inferior angle. *h* Neck. *i* Posterior edge or base. *j* Spine of scapula. *k* Point of attachment of rhomboideus minor. *l* Acromion process. *m* Nutritious foramen. *n* Coracoid process. *o* Point where the deltoid is attached.

union of the superior and anterior costa is the *anterior* angle, which contains the *glenoid cavity*. This cavity is ovoidal, deepened by the glenoid ligament, and is broader below than above. It is covered with cartilage, and has the long head of the biceps arising from its superior margin. It articulates with the head of the humerus. Behind this cavity the bone contracts, and is called the *neck* or *cervix*, The *inferior* angle is formed by the junction of the base and anterior costa; it presents a flat surface for the origin of the teres major.

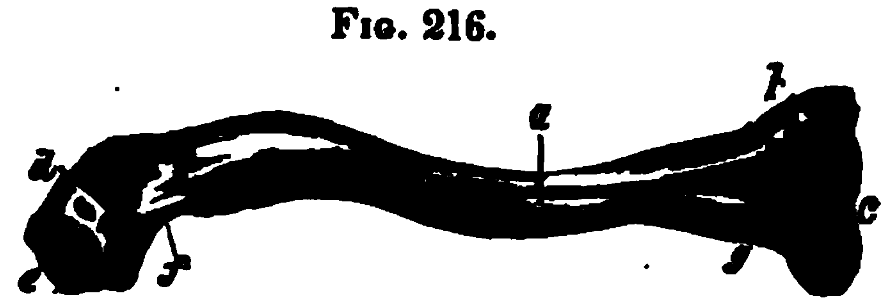
Structure.—The scapula is composed of two compact layers with cellular substance between them. The latter is most abundant in the processes, while in the centre of the dorsum the bone is diaphanous. Its *development* takes place from several points, one for each of the processes, one for the centre of the body, one for the base, and one for the inferior angle.

An ossific centre is noticed in the infra spinal fossa about the seventh or eighth week, during the first year in the coracoid process, at puberty in the acromion process, in the fifteenth year at the inferior angle, during the seventeenth or eighteenth year at the base, and about the twentieth or twenty-fifth year the bone is found complete.

THE CLAVICLE OR COLLAR BONE.

The clavicle is *situated* transversely, between the upper extremity of the sternum and the acromion process of the scapula. Its *shape* is that of the italic *s*.

FIG. 216.



It is longer in the female than the male, and consists of a body and two extremities. The body is rather cylindrical at the sternal, and flattened at the acromial end. Its

FIG. 216 represents the Clavicle. *a* Anterior surface. *b* Point of attachment of sterno-cleido mastoid muscle. *c* Sternal end of Clavicle. *d* Acromial end. *e* Articular surface. *f* Where the conoid ligament is attached. *g* Where the rhomboid ligament is attached.

upper surface is smooth. Its lower presents a ridge for the attachment of the rhomboid or costo-clavicular ligament, and a groove for the subclavian muscle. The sternal portion is convex in front, and concave behind. The humeral end is just the reverse. Two-thirds of the anterior margin give origin to the pectoralis major, the rest to the deltoid muscle. The posterior margin has one or more foramina for nutritious vessels. The sternal superior surface gives origin to the sterno-cleido-mastoideus. The sternal extremity is triangular, thick, and forms the articulating surface. Its margin has ligaments attached to it. The *acromial* end is flat, presents an articular surface, and covers the coracoid process.

Its *Structure* is compact and cellular. The former is very condensed and strong in the centre of the bone; the latter abounds mostly at the extremities.

Function.—To support the scapula and prevent its falling forward or inward, and also to protect the vessels and nerves as they pass to the extremity. Its development is from two points of ossification, (one for the body and the other for the sternal end) and is found to be very perfect in the fœtus. Ossification begins in the clavicle sooner than in any other bone, as early even as the fifth week of intrauterine life. The sternal epiphysis is ossified during the fifteenth and twentieth years. It is *articulated* to the sternum and scapula.

SECTION II.

THE HUMERUS OR ARM-BONE.

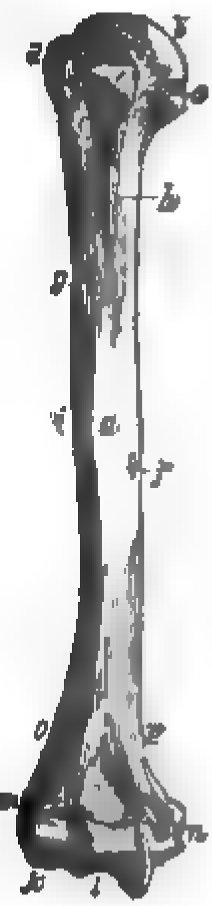
The humerus is the largest bone in the upper extremity, and is *situated* between the scapula above, and the radius and ulna below. It consists of a body and two extremities.

The *body* or *shaft* is cylindrical; its upper anterior fourth is divided by the *bicipital groove* which lodges the long head of the biceps muscle. The anterior edge of this groove has the pectoralis major inserted into it; its posterior edge receives the insertions of the latissimus dorsi and teres major muscles. About the centre of this bone is seen a rough tri-

angular surface for the insertion of the deltoid muscle, and about the same point an oblique vascular foramen. The posterior surface is smooth, and covered by the triceps muscle.

The upper or scapular extremity presents a smooth, hemispherical surface, covered with cartilage, and called the *head*. It articulates with the glenoid cavity of the scapula. Just below and around the head there is a furrow or contraction of the bone called its *neck*. It is rough and gives attachment to the capsular ligament. Below the neck the humerus swells into two processes called *tuberosities*. They are two in number, *external* and *internal*, or the greater and lesser. The external presents three depressions; the *anterior*, *middle*, and *posterior*. To the *anterior* the supra spinatus, to the *middle* the infra spinatus, and to the *posterior* the teres minor muscles are attached. The *internal* tuberosity gives insertion to the tendon of the subscapularis.

Fig. 217.



The inferior extremity of the humerus is flattened, and is bounded externally and internally by two ridges for the attachment of muscles and the intermuscular ligaments. These ridges lead to the two projections called *condyles*. The *internal condyle* is most prominent and has attached to it the internal lateral ligament, and the pronator and flexor muscles. The *external condyle*, less prominent, gives attachment to the external lateral ligament and to the supinator and extensor muscles. Between these two condyles a smooth articulating surface is observed, separated by a ridge. The

Fig. 217 represents the anterior surface of the Humerus. *a* Shaft or body of the Humerus. *b* Head. *c* Anatomical neck. *d* Greater tuberosity. *e* Lesser tuberosity. *f* Bicipital groove. *g* Point of insertion for the pectoralis major. *h* Internal bicipital ridge. *i* Point where the deltoid is inserted. *j* Nutritious foramen. *k* Articular surface for the radius. *l* Articular surface for the ulna. *m* External condyle. *n* Internal condyle. *o p* Condyloid ridges. *q* Lesser sigmoid cavity.

inner portion, called the *trochlea*, is the larger, and articulates with the ulna. The outer receives the head of the radius. Above the trochlea, and in front of the humerus, is the anterior or lesser *cavity* for receiving the coronoid process of the ulna. Behind the humerus, and above the trochlea, is the posterior or greater *cavity* for receiving the olecranon process of the ulna. Between these two cavities the bone is transparent, and sometimes wanting.

Structure.—The humerus consists of compact structure in its body, and is cellular at its extremities. It contains a large medullary canal. It is *articulated* to the scapula, radius and ulna. Its *development* is from eight points, viz: one for the body, one for the head, one for each tuberosity, one for the trochlea, one for each condyle, and one for the small head. Ossification is noticed to begin shortly after that of the clavicle. At birth the extremities are found cartilaginous, while the bony shaft is nearly complete. From the close of the first and during the second and third years, ossific centres are observed in the head and tuberosities—during the third and sixth years the trochlea and small head of the humerus—during the fifth to the seventeenth year ossification appears in the condyles, and the bone is found complete about the twentieth year.

SECTION III.

BONES OF THE FOREARM—THE RADIUS, (Fig. 218.)

The radius is situated upon the outer side of the ulna, the palm of the hand looking upward, and is the shorter bone of the two occupying the forearm.

It consists of a body and two extremities. The body or shaft of the radius presents three surfaces, and is rather triangular in shape. The *anterior surface* is covered below by the pronator quadratus, and is there broad; a little above its centre is seen the orifice of an oblique vascular canal. The *posterior surface* is convex above and gives attachment to the supinator brevis, and is concave in the middle for the extensors of the thumb. The *external surface* is round, and in its centre is rough for the insertion of the pronator teres.

The upper extremity, styled the *head*, presents two smooth articulating surfaces; the one, a superficial cavity, and superior, articulates with the small head of the humerus; the other forms the circumference and articulates with the lesser sigmoid cavity of the ulna. Below the head the bone contracts, and is called the *cervix* or *neck*. Below the neck, or where the latter and the body unite, is the *tubercle* which gives insertion to the tendon of the biceps. It is also covered by a bursa. The lower or carpal extremity is the larger of the two, and is widest transversely. It is bounded externally by the *styloid* process, which gives attachment to the external lateral ligament of the wrist. Internally is a smooth concave surface for articulating with the lower end of the ulna. The carpal surface is smooth and divided by a ridge into two unequal articulating portions; the outer and larger is for the scaphoid bone, the inner receives the lunar. The margin of the carpal surface presents a prominent ridge to which the capsular ligament is attached. On the posterior surface of this carpal extremity several grooves are noticed. At the side and base of the styloid process is a groove for the tendons of the extensor ossis metacarpi, and minor pollicis muscles. Next to this is a larger groove for the tendons of the extensor carpi radialis longior and brevior. On the middle, and next in order, is a groove for the extensor major pollicis, and on the ulnar side of this is another and larger for the extensor communis and indicator. *Structure.*—Cellular in the extremities and compact in the centre.

FIG. 218.

FIG. 218 represents the Radius and Ulna. *a* Shaft of the ulna. *b* The greater sigmoid cavity. *c* Lesser sigmoid cavity. *d* Olecranon process. *e* Coronoid process. *f* Nutritious foramen. *g* Sharp edge for attachment of interosseous membrane. *h* Lower extremity of ulna. *i* Styloid process. *j* Shaft of radius. *k* Its head. *l* Neck. *m* Its tuberosity. *n* Oblique line. *o* Lower extremity of radius. *p* Its styloid process.

inner portion, called the *trochlea*, is the larger, and articulates with the ulna. The outer receives the head of the radius. Above the trochlea, and in front of the humerus, is the anterior or lesser *cavity* for receiving the coronoid process of the ulna. Behind the humerus, and above the trochlea, is the posterior or greater *cavity* for receiving the olecranon process of the ulna. Between these two cavities the bone is transparent, and sometimes wanting.

Structure.—The humerus consists of compact structure in its body, and is cellular at its extremities. It contains a large medullary canal. It is *articulated* to the scapula, radius and ulna. Its *development* is from eight points, viz: one for the body, one for the head, one for each tuberosity, one for the trochlea, one for each condyle, and one for the small head. Ossification is noticed to begin shortly after that of the clavicle. At birth the extremities are found cartilaginous, while the bony shaft is nearly complete. From the close of the first and during the second and third years, ossific centres are observed in the head and tuberosities—during the third and sixth years the trochlea and small head of the humerus—during the fifth to the seventeenth year ossification appears in the condyles, and the bone is found complete about the twentieth year.

SECTION III.

BONES OF THE FOREARM—THE RADIUS, (Fig. 218.)

The radius is situated upon the outer side of the ulna, the palm of the hand looking upward, and is the shorter bone of the two occupying the forearm.

It consists of a body and two extremities. The body or shaft of the radius presents three surfaces, and is rather triangular in shape. The *anterior surface* is covered below by the pronator quadratus, and is there broad; a little above its centre is seen the orifice of an oblique vascular canal. The *posterior surface* is convex above and gives attachment to the supinator brevis, and is concave in the middle for the extensors of the thumb. The *external surface* is round, and in its centre is rough for the insertion of the pronator teres.

The upper extremity, styled the *head*, presents two smooth articulating surfaces; the one, a superficial cavity, and superior, articulates with the small head of the humerus; the other forms the circumference and articulates with the lesser sigmoid cavity of the ulna. Below the head the bone contracts, and is called the *cervix* or *neck*. Below the neck, or where the latter and the body unite, is the *tubercle* which gives insertion to the tendon of the biceps. It is also covered by a bursa. The lower or carpal extremity is the larger of the two, and is widest transversely. It is bounded externally by the *styloid* process, which gives attachment to the external lateral ligament of the wrist. Internally is a smooth concave surface for articulating with the lower end of the ulna. The carpal surface is smooth and divided by a ridge into two unequal articulating portions; the outer and larger is for the scaphoid bone, the inner receives the lunar. The margin of the carpal surface presents a prominent ridge to which the capsular ligament is attached. On the posterior surface of this carpal extremity several grooves are noticed. At the side and base of the styloid process is a groove for the tendons of the extensor ossis metacarpi, and minor pollicis muscles. Next to this is a larger groove for the tendons of the extensor carpi radialis longior and brevior. On the middle, and next in order, is a groove for the extensor major pollicis, and on the ulnar side of this is another and larger for the extensor communis and indicator. *Structure.*—Cellular in the extremities and compact in the centre.

FIG. 218.

FIG. 218 represents the Radius and Ulna. *a* Shaft of the ulna. *b* The greater sigmoid cavity. *c* Lesser sigmoid cavity. *d* Olecranon process. *e* Coronoid process. *f* Nutritious foramen. *g* Sharp edge for attachment of interosseous membrane. *h* Lower extremity of ulna. *i* Styloid process. *j* Shaft of radius. *k* Its head. *l* Neck. *m* Its tuberosity. *n* Oblique line. *o* Lower extremity of radius. *p* Its styloid process.

Its *development* is from three points, one for the body and one for each extremity. Ossification begins in the radius during the sixth week, shortly after that of the humerus. At birth both extremities are cartilaginous. In the lower end an ossific point is seen about the close of the second year, and in the upper end from the fifth to the seventh, the bone being completed about the twentieth year. It is *articulated* to the humerus, ulna, scaphoid and lunar bones.

THE ULNA, (Fig. 218.)

The ulna is situated at the inner side of the radius, the palm of the hand being uppermost. It is triangular in shape, and consists also in a body and two extremities. The body presents three ridges and three surfaces. The external or radial ridge is most prominent, runs the greater part of the length of the bone and gives attachment to the interosseous ligament; the anterior ridge is round, and has the flexor profundus and pronator quadratus attached to it; the posterior ridge is distinct above and gives attachment to the anconeus. Between these ridges are so many surfaces all covered by muscles. The anterior surface has a foramen a little above its centre, looking obliquely upward, and conducts the nutritious vessel. The superior extremity is much larger than the lower and forms the greater portion of the elbow-joint. It presents two processes; the one anterior and smaller, called *coronoid;* the other posterior and much larger, termed *olecranon.* The coronoid process is triangular and sharp, and is received into the anterior cavity of the lower end of the humerus. Its anterior surface gives insertion to the brachialis anticus muscle. Its outer surface is hollowed into the *lesser sigmoid cavity,* which articulates with the side of the head of the radius.

The olecranon process has its posterior surface covered by a bursa, and is rough for the insertion of the tendon of the triceps, and its extremity presents a point which is received into the posterior or greater cavity of the humerus. Between these two processes is a large concave surface,

smooth, and covered with cartilage, called *the greater sigmoid cavity*, which receives the trochlea of the humerus. This cavity is divided by a vertical ridge, and about its centre by a transverse ridge, which terminates internally in a notch, in which fatty matter is found.

The inferior or carpal extremity is small, and presents a projecting process, called the *styloid*, to which the internal lateral ligament of the wrist is attached. External to this process is a round smooth head for articulating with the small cavity on the inner side of the radius; and between these two processes, on the back of the ulna, is a groove for the passage of the tendon of the extensor carpi ulnaris.

Structure.—Same as the radius. Like that bone, it is *developed* from three points of ossification. Ossification begins in the ulna during the sixth week, shortly after it takes place in the radius and humerus. At birth both extremities are cartilaginous. The lower end has in its centre an ossific point about the fourth or fifth year. The olecranon is ossified from the seventh to the tenth, and the bone is completed about the twentieth year. It is articulated to the humerus and radius.

SECTION IV.

THE HAND.

The *Hand* is composed of the *carpus*, *metacarpus*, and *phalanges*.

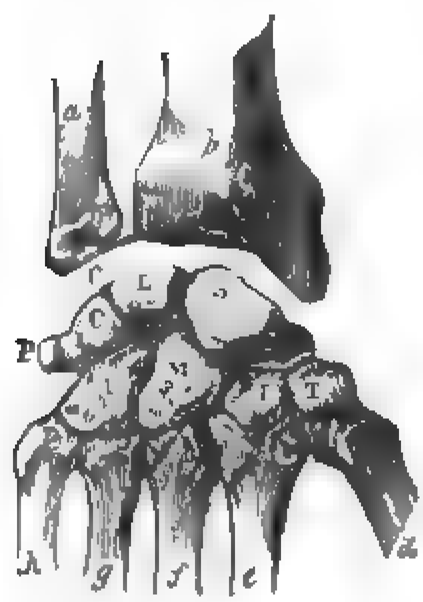
THE CARPUS OR WRIST, (Fig. 219.)

The carpus consists of two rows of bones, eight in number. The first row contains the os scaphoides, lunare, cuneiforme, and pisiforme, which are adjacent to the bones of the forearm. The second row is next to the metacarpus, and contains the trapezium, trapezoides, magnum and unciforme.

The *os scaphoides*, (os naviculare,) so called from its fancied resemblance to a boat, is situated upon the radial side, and is the largest bone in the upper row. Its upper sur-

face is convex and articulates with the radius. Its lower surface is concavo-convex and articulates with the trapezium and trapezoid. Its ulnar or inner surface articulates with the os-lunare and os magnum, while its external or radial face gives attachment to the external lateral ligament.

FIG. 219.



The *os-lunare,* so called from its semi-lunar shape, is convex above to receive the radius, and concave below to articulate with the magnum and unciforme. Its ulnar surface joins the cuneiform, its radial the scaphoid.

The *os-cuneiforme,* so named from its wedge-like shape, is on the ulnar side of the lunar, and articulates with it. The lower surface is concave, and articulates with the unciforme, and its anterior surface is flat and smooth where it joins the pisiforme.

The *os pisiforme,* so called from its resemblance in size and form to a pea, is the smallest bone in the wrist, and is *situated* upon the palmar surface of the last, with which it is articulated. It gives insertion to the flexor carpi ulnaris above, and origin to the abductor minimi digiti below.

The *trapezium* is the first bone on the radial side of the second row; it is concave above to receive the scaphoid, and below it joins the metacarpal bone of the thumb. Internally it articulates with the trapezoides and second metacarpal bone; on its anterior surface is observed a groove for the tendon of the flexor carpi radialis.

The *trapezoides* is smaller than the last, with which it articulates, and of very irregular shape. Above it is con-

FIG. 219 represents the Carpus. *a* Ulna. *b* Radius. *c* Inter-articular-fibro cartilage. *d* Metacarpal bone of the thumb. *e* Metacarpal bone of the first finger. *f* Metacarpal bone of the second finger. *g* Metacarpal bone of the third finger. *h* Metacarpal bone of the fourth finger. *S* Scaphoides. *L* Lunare. *C* Cuneiforme. *P* Pisiforme. *T T* Trapezium and trapezoides. *M* Os magnum. *U* Unciforme.

cave to join the scaphoid; below it unites with the second metacarpal bone, and internally with the os magnum.

The *os magnum*, so named from its size, is *situated* upon the ulnar side of the last, and is the largest of the bones of the carpus. Its superior surface articulates with the scaphoid and lunar bones; its inferior, with the second, third, and fourth metacarpal. Internally it meets the unciform, externally the trapezoides. The dorsal surface is broad, the palmar narrow.

The *os unciforme*, so named from its hook-like process, is the next in size to the os magnum. Its superior surface joins the os-lunare, its external the magnum, its internal the cuneiform, and its base the fourth and fifth metacarpal. Its *dorsal surface* is rough; and its *palmar* presents the hook-like process for the attachment of the annular ligament.

Structure.—The bones of the carpus consist of cellular structure, covered by a delicate lamina of compact bone. They are developed from a single point of ossification, except the unciform, which has two.

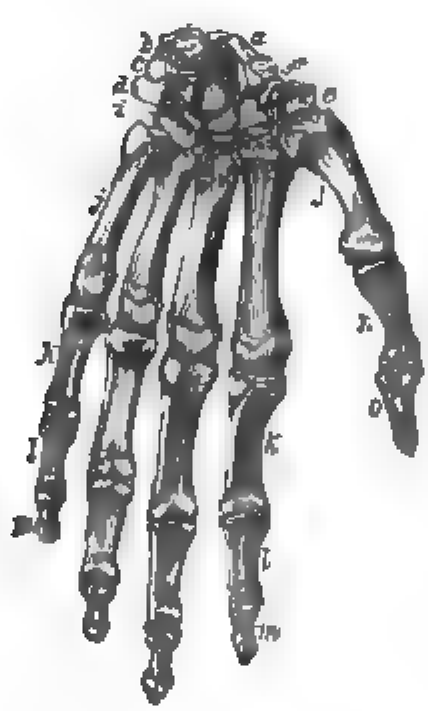
Ossification is observed to begin in the os magnum and unciforme, at the close of the first year; in the cuneiform, at the close of the third; in the trapezium and semilunare, in the fifth; in the scaphoid, from the sixth to the eighth; in the trapezoides, from the eighth to the ninth, and in the pisiforme in the twelfth year.

THE METACARPUS, (Fig. 220.)

The metacarpus is situated between the carpus and the phalanges, and consists of five bones. Those corresponding to the fingers are parallel to each other; the one for the thumb stands out from the rest at an angle. Each metacarpus is composed of a head, shaft and base. The head is at the digital extremity, and articulates with the first phalanx of the fingers; the shaft is triangular, and marked laterally for the attachment of the interossei muscles; the base is superior, and articulates with its fellows and with the carpal bones.

All the bones of the metacarpal series have a convexity on their dorsal surface and a concavity on their palmar.

Fig. 220.



The *metacarpal bone* of the thumb is the strongest and shortest of the whole; its slightly concave carpal end articulates with the trapezium; its slightly concave phalangeal end with the first bone of the thumb. On either side of the phalangeal extremity a tubercle is seen on which is placed a sesamoid bone.

The *second metacarpal bone, or that of the forefinger,* is distinguished from the rest by its greater length; it articulates at its carpal end by a deep concavity in the middle with the trapezoides. There is a smooth articular face for the trapezium on the one side and the magnum on the other. The base, on its palmar surface, presents a rough portion for the insertion of the *flexor carpi radialis,* and a like roughness on the dorsal base for the insertion of the *extensor carpi radialis longior.* The palmar portion of the shaft is divided by a longitudinal ridge into two surfaces for the interosseous muscles.

The *third metacarpal bone* is the next in size, but rather shorter than the last. Its carpal extremity is triangular, and articulates with the os magnum; it has on its radial side a tubercle for the insertion of the *extensor carpi radialis brevior.* On either side of the base are seen articular faces for the second and fourth metacarpal bones.

The *fourth metacarpal bone* is smaller and shorter than the third. Its carpal extremity articulates with the unci-

Fig. 220 represents the Metacarpus and Phalanges. *a* Scaphoides. *b* Lunare. *c* Cuneiforme. *d* Pisiforme. *e* Trapezium. *f* Groove for tendon of flexor carpi radialis *g* Trapezoides. *h* Os-magnum. *i* Unciforme. *j j* Metacarpal bones. *k k* Phalanges—first row. *l l* Phalanges—second row. *m m* Phalanges—third row. *n* First phalanx of the thumb. *o* Last phalanx of the thumb.

forme and the magnum, and by its lateral portions with the third and fifth metacarpal bones.

The *fifth metacarpal bone* is smaller and shorter than the fourth. Its carpal extremity presents a double articulating surface, the larger for the unciforme, the smaller for the fourth metacarpal bone. The base presents a tubercle for the insertion of the *extensor carpi ulnaris.*

Development.—Ossification of the metacarpal bones commences by two centres—one for the digital extremity, and one for the shaft. About the tenth or twelfth week the metacarpal bone of the thumb presents an exception to this rule, by having its ossific centre in the carpal extremity. The epiphyses show themselves about the second or third year; and about the twentieth the metacarpal row is completed.

THE PHALANGES, (Fig. 220.)

The phalanges compose the bones of the thumb and fingers, and have each a shaft and two extremities.

The thumb has two bones; each of the fingers three, placed in rows. The first row or phalanx is next to the metacarpal bones. The bones of this row have their base concave for receiving the head of the corresponding metacarpal bone, and, on either side, a small tubercle for the lateral ligament. The lower extremity presents two small heads, or a pulley-like formation, for articulating with the second phalanx; the sides form ridges for the thecal attachments. The dorsal surface is convex and smooth, the palmar concave.

The *second phalanx* is smaller than the first; its superior extremity presents two small cavities for the two heads of the first phalanx; the lower extremity is slightly concave for articulation with the third phalanx.

The third or last *phalanx* is the smallest of the three, and is remarkable for having its lower extremity flat, thin, and semicircular, and its palmar surface rough. The first phalanx of the thumb is stronger and shorter than those of the fingers, while its second or last phalanx is broader.

Development.—The phalanges are developed from two centres—one for the base and one for the shaft. Ossification begins about the same time as in the metacarpal bones, and is observed first in the third phalanx, then in the first, and last of all in the second phalanx. During the third and fourth years the epiphyses of the first row are seen; during the fourth and fifth those of the second row; and during the sixth and seventh year those of the last row. All the phalanges are completed by the twentieth year.

SECTION V.

LIGAMENTS OF THE SUPERIOR EXTREMITY.

The ligaments to be considered are those of the *shoulder, arm, forearm,* and *hand.*

LIGAMENTS OF THE SHOULDER.

The bones of the shoulder being composed of the clavicle and scapula, we have clavicular and scapular ligaments; and the clavicle being connected with the sternum, ribs, and scapulæ, we have hence a division of the ligaments into sterno-clavicular, costo-clavicular, and scapulo-clavicular.

Sterno-clavicular articulation, (Fig. 141.)—This articulation has a capsular ligament, an inter-articular cartilage, an inter-clavicular ligament, and two synovial membranes.

The capsular ligament is a strong, fibrous, membrane surrounding the joint, and covered by the origin of the sterno-cleido-mastoideus at its anterior portion. This capsule has its fibres thickened in front and behind—hence the names of the *anterior* and *posterior sterno-clavicular ligaments.*

The *anterior,* called also the radiated ligament, proceeds from the anterior extremity of the clavicle downward and inward to the articular margin of the cavity of the sternum. The *posterior* is not so distinct, but pursues a course behind the joint similar to the anterior.

The *inter-articular cartilage* is seen on opening the joint. It is circular in shape, and completely separates the ster-

num and clavicle. Below it is thin, where it is attached to the sternum; above it is thick, where it is connected to the clavicle. Its centre is thin and sometimes perforated. Its structure is fibro-cartilaginous, and its use seems to be to adapt the bony surfaces to one another as well as to bind them together.

The *synovial membranes* are two in number, one on each side of the inter-articular cartilage. They are found to contain but little synovia, and are strongly attached to the adjacent surfaces.

Costo-clavicular articulation, (Fig. 141.)—This articulation has a short bundle of parallel ligamentous fibres, called the *rhomboid* or *inferior ligament*, running obliquely downward and forward from the inferior surface of the sternal end of the clavicle, to be inserted into the upper surface of the cartilage of the first rib. Posteriorly it is in contact with the subclavian vein, and anteriorly with the subclavian muscle.

The *inter-clavicular ligament* is placed at the superior end of the sternum, and extends from the posterior sternal extremity of one clavicle to that of the other.

Scapulo-clavicular articulation, (Fig. 221.)—This articulation has a capsular ligament at the junction of the acromion process and clavicle, whose fibres being thickened above and below, and passing from one bone to the other, receive the name of *superior* and *inferior* ligaments. A synovial membrane, somewhat indistinct, is seen upon the articular surface of this joint, and occasionaly an inter-articular cartilage is found.

The *coraco-clavicular ligament* is double, and consists of the conoid and the trapezoid.

The *conoid* is the smaller and posterior of the two; its base is above and attached to the tubercle on the inferior surface of the acromial end of the clavicle. The *trapezoid* is more anterior and external; it is broader, longer and thinner than the conoid, and is attached above to an oblique line on the under surface of the clavicle at the tubercle, and below to the root of the coracoid process.

Development.—The phalanges are developed from two centres—one for the base and one for the shaft. Ossification begins about the same time as in the metacarpal bones, and is observed first in the third phalanx, then in the first, and last of all in the second phalanx. During the third and fourth years the epiphyses of the first row are seen; during the fourth and fifth those of the second row; and during the sixth and seventh year those of the last row. All the phalanges are completed by the twentieth year.

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Sterno-clavicular articulation, (Fig. 141.)—This articulation has a capsular ligament, an inter-articular cartilage, an inter-clavicular ligament, and two synovial membranes.

The capsular ligament is a strong, fibrous, membrane surrounding the joint, and covered by the origin of the sterno-cleido-mastoideus at its anterior portion. This capsule has its fibres thickened in front and behind—hence the names of the *anterior* and *posterior sterno-clavicular ligaments.*

The *anterior,* called also the radiated ligament, proceeds from the anterior extremity of the clavicle downward and inward to the articular margin of the cavity of the sternum. The *posterior* is not so distinct, but pursues a course behind the joint similar to the anterior.

The *inter-articular cartilage* is seen on opening the joint. It is circular in shape, and completely separates the ster-

num and clavicle. Below it is thin, where it is attached to the sternum; above it is thick, where it is connected to the clavicle. Its centre is thin and sometimes perforated. Its structure is fibro-cartilaginous, and its use seems to be to adapt the bony surfaces to one another as well as to bind them together.

The *synovial membranes* are two in number, one on each side of the inter-articular cartilage. They are found to contain but little synovia, and are strongly attached to the adjacent surfaces.

Costo-clavicular articulation, (Fig. 141.)—This articulation has a short bundle of parallel ligamentous fibres, called the *rhomboid* or *inferior ligament*, running obliquely downward and forward from the inferior surface of the sternal end of the clavicle, to be inserted into the upper surface of the cartilage of the first rib. Posteriorly it is in contact with the subclavian vein, and anteriorly with the subclavian muscle.

The *inter-clavicular ligament* is placed at the superior end of the sternum, and extends from the posterior sternal extremity of one clavicle to that of the other.

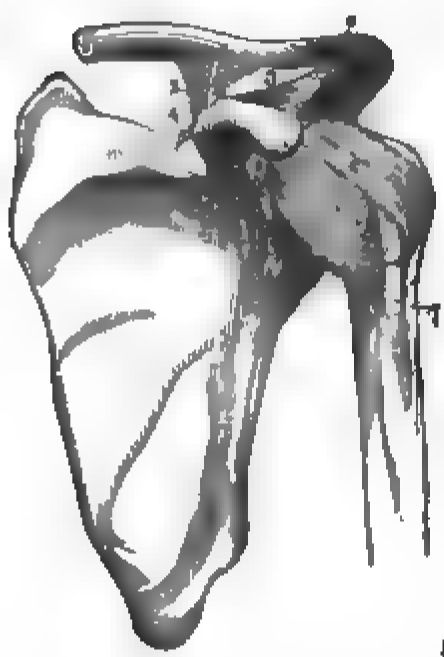
Scapulo-clavicular articulation, (Fig. 221.)—This articulation has a capsular ligament at the junction of the acromion process and clavicle, whose fibres being thickened above and below, and passing from one bone to the other, receive the name of *superior* and *inferior* ligaments. A synovial membrane, somewhat indistinct, is seen upon the articular surface of this joint, and occasionaly an inter-articular cartilage is found.

The *coraco-clavicular ligament* is double, and consists of the conoid and the trapezoid.

The *conoid* is the smaller and posterior of the two; its base is above and attached to the tubercle on the inferior surface of the acromial end of the clavicle. The *trapezoid* is more anterior and external; it is broader, longer and thinner than the conoid, and is attached above to an oblique line on the under surface of the clavicle at the tubercle, and below to the root of the coracoid process.

Between these two ligaments fatty and cellular structures are seen, and occasionally a small bursa.

Fig. 221.



The *ligamentum bicorne*, called also the clavicular fascia, springs from the root of the coracoid process and divides, whence it receives the name of the *bifid ligament*. One of the divisions goes to the first rib, the other spreads over the subclavius muscle as a fascia, and extends as far forward as the rhomboid ligament.

The *ligaments of the scapula* are the coracoid and the triangular. (Fig. 221.)

The *coracoid* is posterior, and is stretched across the notch in the superior costa of the scapula, converting it into a foramen.

The *triangular* is anterior, and is also called *deltoid* or *coraco-acromial*. It has a broad origin from the superior margin of the coracoid process. Its fibres, which are thin and partially separated, converge, become thicker, and are inserted into the acromion process where it joins the clavicle. This ligament forms an arch over the shoulder joint, and is covered by the deltoid muscle.

LIGAMENTS OF THE ARM.

The *humero-scapular articulation* contains the following ligaments :—1st, The capsular ligament (Fig. 221); 2d, The coraco-humeral; 3d, The glenoid.

The *capsular ligament* completely surrounds this joint, being attached above to the margin of the glenoid cavity, and below to the neck of the humerus. Above and below it is dense internally, and externally it is thin. It is loose and has connected with it the tendons of the four capsular

Fig. 221 represents the Ligaments of the Shoulder Joint. 1 Superior acromio clavicular ligament. 2 Coraco-clavicular ligament. 3 Coraco-acromial ligament. 4 Coracoid ligament. 5 Capsular ligament. 6 Coraco-humeral, or ligamentum adscititium. 7 Tendon of the long head of the biceps muscle.

muscles, which almost completely surround it, except a small portion below and internally, where it is consequently weaker, and where dislocations of this joint are found most commonly to occur.

The *coraco-humeral, accessory ligament,* or *ligamentum adscititium* extends beneath the triangular ligament downward and outward to the greater tuberosity, where it is lost in the capsular. This ligament serves to keep the head of the humerus in the glenoid cavity.

The *glenoid ligament* surrounds the margin, and deepens the glenoid cavity; its free edge is thin, but where it connects with the bone it is thick. The tendon of the biceps partly contributes to this ligament.

The *synovial membrane* lines the capsular ligament and glenoid surface, is reflected over the head of the humerus, lines the bicipital groove, and forms a sheath around the tendon of the biceps.

LIGAMENTS OF THE FOREARM.

The *ligaments of the forearm* are found in the *humero-cubital articulation,* or the *elbow joint,* and are, 1st, The capsular ligament; 2d, External lateral or brachio-radial; 3d, Internal lateral or brachio-ulnar; 4th, Coronary ligament; 5th, Ligamentum teres.

The *capsular ligament* surrounds the elbow joint, and is connected above to the lower end of the humerus, above the articular surface, and below to the articular margin of the ulna and neck of the radius.

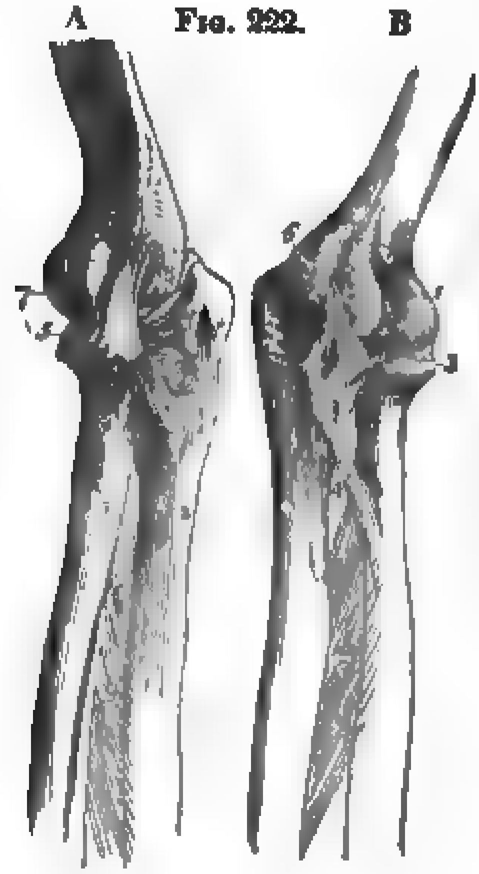
The *external lateral ligament* extends from the external condyle above to the annular ligament surrounding the neck of the radius below.

The *internal lateral ligament* extends from the internal condyle, expands and divides as it descends, one portion going to the coronoid process, the other to the olecranon.

Between the lateral ligaments in front and behind the joint, the capsular ligament is thin, its fibres insulated, some taking an oblique, others a straight course, and receiving the name of *accessory ligaments.*

The *coronary* or *annular ligament* surrounds about two-thirds of the neck of the radius, and is seen by opening the joint. It extends from the lesser sigmoid cavity of the ulna at its anterior margin, round the radius to the posterior margin of the same cavity.

A Fig. 222. B



The *ligamentum teres* or *oblique ligament* is a round, short, fibrous cord, extending from the root of the coronoid process to the radius below its tubercle.

The *synovial membrane* is common to the three bones composing the humero-cubital articulation, as well as the two sigmoid cavities and neck of the radius.

The *interosseous ligament* occupies the space between the radius and ulna, being attached to the corresponding edges of those bones, and perforated at its upper and lower extremities.

LIGAMENTS OF THE HAND.

The *ligaments of the hand* include those of the *carpus*, *metacarpus*, and *phalanges*.

LIGAMENTS OF THE CARPUS OR WRIST JOINT.

The *ligaments* of the *carpus*, or *wrist-joint*, include the *capsular ligament*, *external lateral* or *radio-carpal*, *internal lateral* or *ulna-carpal*, *triangular ligament*, and *annular ligament*.

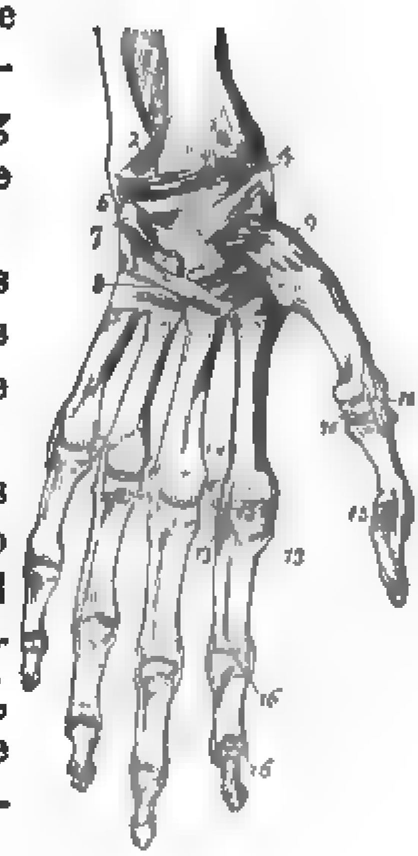
The *capsular ligament* is connected above to the articular

Fig. 222, A represents an outer view of the Elbow Joint. 1 The humerus. 2 Ulna. 3 Radius. 4 External lateral ligament. 5 Coronary ligament. 6 Point of attachment of the coronary ligament. 7 8 Accessory ligaments. 9 Interosseous ligament.

Fig. 222, B represents an inner view of the Elbow Joint. 1 Capsular Ligament. 2 Internal lateral ligament. 3 Coronary ligament. 4 Ligamentum teres. 5 Interosseous ligament. 6 Internal condyle.

margin of the lower ends of the radius and ulna, and below to the margin of the three carpal bones of the first row, the scaphoides, lunare, and cuneiforme, fibres being traced also to the bones of the second row. This ligament is loose and thin, presenting spaces at different points at which the synovial membrane appears.

FIG. 223.



The *external lateral ligament* extends from the styloid process of the radius to the scaphoides, and on even to the trapezium and annular ligament.

The *internal lateral ligament* extends from the styloid process of the ulna to the cuneiform bone, and is long and round. Between the lateral, *anterior* and *posterior* ligaments are spoken of, which are simply a thickening of the capsular on the front and back portions of the joint.

The *triangular ligament* is fibro-cartilaginous, and is connected with the styloid process of the ulna and the carpal end of the radius, separating the ulna from the cuneiform bone. It is sometimes perforated, and seems to be a continuation of the cartilage on the lower extremity of the radius.

The *annular ligament* is a strong fibrous membrane, attached externally to the scaphoid and trapezium, and internally to the cuneiform, unciform and pisiform bones. It gives the arched form at the wrist, and keeps the flexor tendons in their proper places, and on the back of the

FIG. 223 represents the Ligaments of the Wrist Joint. 1 Interosseous ligament. 2 Radio-ulnar. 3 Capsular ligament. 4 External lateral. 5 Internal lateral ligament. 6 Capsular ligament of the carpal bones. 7 Os-pisiforme. 8 Ligaments joining the metacarpal with the second row of the carpus. 9 Capsular ligament of the carpo-metacarpal joint of the thumb. 10 Capsular ligament of the metacarpo-phalangeal joint of the thumb. 11 External lateral ligament of the same joint. 12 Capsular ligament of the metacarpo phalangeal joint of the index finger. 13 13 Lateral ligaments of similar articulations. 14 Inferior palmar ligaments. 15 Capsular and lateral ligaments of the last joint of the thumb.

Deltoid—Δ, delta, ειδος, likeness, (Figs. 150,167.)—*Dissection.*—Make the first incision along the posterior third of the clavicle, the acromial margin, and spine of the scapula; the second from the acromion process, along the middle of the humerus, and commence the dissection from this last incision, turning off the integuments internally and externally with the cellular structure, when this muscle will be exposed. It *arises* from the external third of the clavicle, fleshy; from the outer margin of the acromion process, tendinous and fleshy; and from the whole of the inferior edge of the spine of the scapula. It is *inserted* on the outer side of the humerus, near its centre, in a triangular rough surface.

This muscle is triangular in shape, thick and strong, covers the shoulder-joint, and gives it its rotundity. The fibres converge—the anterior descending obliquely backward, the posterior forward, and the middle directly downward, the three presenting so many separate parts or muscles.

Function.—To raise the arm and, according to the direction of the fibres, to draw it either forward or backward. Beneath the superior portion of this muscle, extending under the acromion process, is seen a large bursa.

Supra-spinatus—*supra*, above; *spina*, the spine—(Fig. 150.) By turning down the deltoid this muscle is seen; it *arises* fleshy from the whole of the supra-spinal fossa, also from a strong fascia covering it; it then passes under the acromion process, ending in a strong tendon, which is firmly attached to the capsular ligament, and is *inserted* into the inner face of the greater tuberosity of the humerus.

Function.—To raise the arm and turn it outward; also to strengthen the capsular ligament, and to draw it from between the humerus and glenoid cavity, in the elevation of the arm.

Infra spinatus—*infra*, beneath; *spina*, spine—(Fig. 150,) arises from the whole of the dorsum of the scapula below its spine, from the margins of the bone, and from the aponeurosis covering it, forming a flat, triangular muscle. Its fibres converge, the superior going horizontally, the inferior ascending obliquely forward, to a strong central

tendon, which goes under the acromion process, adheres to the capsular ligament, and is *inserted* into the middle face of the greater tuberosity of the humerus.

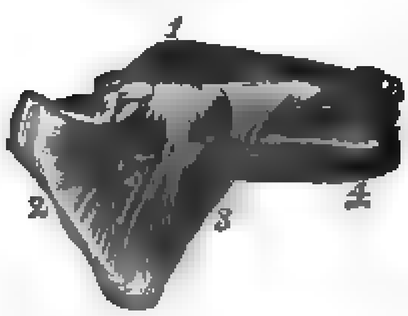
Function.—To roll the os-humeri outward and backward. To strengthen the capsular ligament and to draw it out of the joint, in the outward movements of the arm. There is also a bursa between the tendon of this muscle and the scapula.

Teres minor—teres, round—(Fig. 150,) is a small and narrow muscle, and arises from the inferior costa of the scapula at the lower margin of the infra spinatus, is inseparably attached to, and in fact forms part of this latter muscle. It extends from the cervix to about an inch of the inferior angle, and adhering to the capsular ligament, is *inserted* tendinous and fleshy into the outer face of the great tuberosity of the humerus.

Function.—To rotate the arm outward, and draw it downward and backward.

The teres major (Fig. 224) is a flat muscle, and arises from the inferior angle of the scapula upon its rough flat surface. Forming a thick fleshy belly, it ascends forward and outward, and terminates on the inner side of the arm in a broad thin tendon, which is *inserted* along with the tendon of the latissimus dorsi into the inner or posterior edge of the bicipital groove. The tendon of the teres major is posterior, and extends lower down the arm than the latissimus.

Fig. 224.



Function.—To roll the arm inward, and draw it backward and downward.

The *sub-scapularis* (*sub,* under; *scapula,* shoulder-blade) is a broad triangular muscle, which arises from the whole of the venter, and the superior and inferior costæ of the scapula. Its fibres converge to the neck of the scapula, pass below the coracoid process, adhere to the inferior part of the capsular ligament, and terminate in a strong tendon,

Fig. 224 represents the Muscles of the Shoulder. 1 Deltoid 2 Subscapularis. 3 Teres major. 4 Triceps.

Deltoid—Δ, delta, εἶδος, likeness, (Figs. 150,167.)—*Dissection.*—Make the first incision along the posterior third of the clavicle, the acromial margin, and spine of the scapula; the second from the acromion process, along the middle of the humerus, and commence the dissection from this last incision, turning off the integuments internally and externally with the cellular structure, when this muscle will be exposed. It *arises* from the external third of the clavicle, fleshy; from the outer margin of the acromion process, tendinous and fleshy; and from the whole of the inferior edge of the spine of the scapula. It is *inserted* on the outer side of the humerus, near its centre, in a triangular rough surface.

This muscle is triangular in shape, thick and strong, covers the shoulder-joint, and gives it its rotundity. The fibres converge—the anterior descending obliquely backward, the posterior forward, and the middle directly downward, the three presenting so many separate parts or muscles.

Function.—To raise the arm and, according to the direction of the fibres, to draw it either forward or backward. Beneath the superior portion of this muscle, extending under the acromion process, is seen a large bursa.

Supra-spinatus—*supra*, above; *spina*, the spine—(Fig. 150.) By turning down the deltoid this muscle is seen; it *arises* fleshy from the whole of the supra-spinal fossa, also from a strong fascia covering it; it then passes under the acromion process, ending in a strong tendon, which is firmly attached to the capsular ligament, and is *inserted* into the inner face of the greater tuberosity of the humerus.

Function.—To raise the arm and turn it outward; also to strengthen the capsular ligament, and to draw it from between the humerus and glenoid cavity, in the elevation of the arm.

Infra spinatus—*infra*, beneath; *spina*, spine—(Fig. 150,) arises from the whole of the dorsum of the scapula below its spine, from the margins of the bone, and from the aponeurosis covering it, forming a flat, triangular muscle. Its fibres converge, the superior going horizontally, the inferior ascending obliquely forward, to a strong central

tendon, which goes under the acromion process, adheres to the capsular ligament, and is *inserted* into the middle face of the greater tuberosity of the humerus.

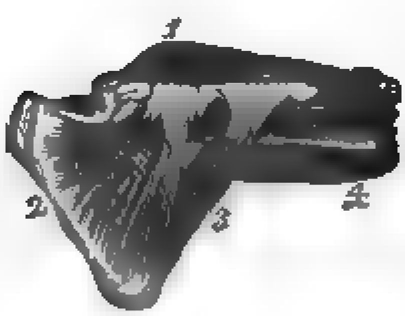
Function.—To roll the os-humeri outward and backward. To strengthen the capsular ligament and to draw it out of the joint, in the outward movements of the arm. There is also a bursa between the tendon of this muscle and the scapula.

Teres minor—teres, round—(Fig. 150,) is a small and narrow muscle, and arises from the inferior costa of the scapula at the lower margin of the infra spinatus, is inseparably attached to, and in fact forms part of this latter muscle. It extends from the cervix to about an inch of the inferior angle, and adhering to the capsular ligament, is *inserted* tendinous and fleshy into the outer face of the great tuberosity of the humerus.

Function.—To rotate the arm outward, and draw it downward and backward.

The teres major (Fig. 224) is a flat muscle, and arises from the inferior angle of the scapula upon its rough flat surface. Forming a thick fleshy belly, it ascends forward and outward, and terminates on the inner side of the arm in a broad thin tendon, which is *inserted* along with the tendon of the latissimus dorsi into the inner or posterior edge of the bicipital groove. The tendon of the teres major is posterior, and extends lower down the arm than the latissimus.

FIG. 224.



Function.—To roll the arm inward, and draw it backward and downward.

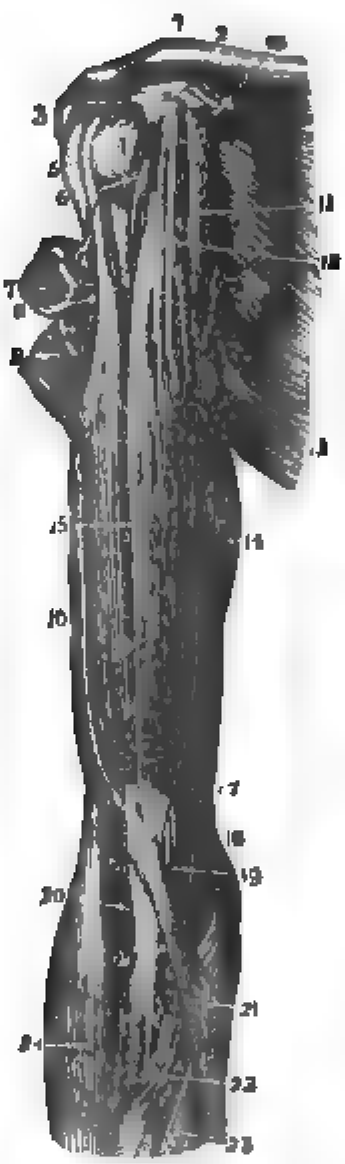
The *sub-scapularis* (*sub*, under; *scapula*, shoulder-blade) is a broad triangular muscle, which arises from the whole of the venter, and the superior and inferior costæ of the scapula. Its fibres converge to the neck of the scapula, pass below the coracoid process, adhere to the inferior part of the capsular ligament, and terminate in a strong tendon,

FIG. 224 represents the Muscles of the Shoulder. 1 Deltoid 2 Subscapularis. 3 Teres major. 4 Triceps.

which is *inserted* into the lesser tuberosity of the humerus. Between the tendon of this muscle and the neck of the scapula, a large bursa communicating with the joint is seen; also another smaller one between the tendon and capsular ligament. *Function.*—To roll the arm inward and downward.

MUSCLES OF THE ARM, (Fig. 225.)

FIG. 225.



These comprise the *biceps flexor cubiti*, *coraco-brachialis*, *brachialis anticus*, *triceps extensor cubiti*, and *anconeus*.

Biceps flexor cubiti. — *Dissection.*— Make an incision along the middle anterior region of the humerus down to the elbow-joint, which cross by a transverse incision at the middle of the arm, turn aside the integuments and fascia, and this muscle will be exposed. It is superficial and forms the swell along the front part of the arm. It *arises* by two heads; the internal or short head comes from the coracoid process in common with the coraco-brachialis; the external or long head arises by a round tendon from the upper part of the glenoid cavity of the scapula, goes through the joint, over the head of the humerus, surrounded by, but external to, the synovial membrane, and then descends through the groove between the tuberosities of the humerus, between the tendons

FIG. 225 represents the Muscles on the front of the Arm. 1 Clavicle. 2 Coracoid process. 3 Acromion process. 4 Head of the humerus. 5 Tendon of the biceps. 6 Ligamentum adscititium. 7 Insertion of pectoralis major. 8 Long head of the biceps. 9 Insertion of the deltoid. 10 Insertion of pectoralis minor. 11 Coraco brachialis. 12 Short head of biceps. 13 Latissimus dorsi. 14 Triceps. 15 Body of the biceps. 16 External part of triceps. 17 Brachialis anticus. 18 Origin of the flexor muscles. 19 Insertion of brachialis anticus. 20 Tendon of the biceps. 21 Bicipital aponeurosis. 22 Flexor carpi radialis. 23 Palmaris longus. 24 Supinator radii longus.

of the latissimus dorsi and teres major behind, and the pectoralis major in front. Becoming fleshy it unites with the belly of the short head, at first loosely by cellular tissue, but a little below the middle of the arm the two heads become inseparably united to form a thick fleshy belly, which a little above the elbow-joint ends in a flat tendon, passing in front of the joint to be *inserted* into the posterior part of the tubercle of the radius.

A bursa is placed between the tendon and the tubercle, and from the ulnar side of the tendon proceeds the bicipital aponeurosis, which, passing over the brachial artery and nerve, joins the general fascia of the forearm.

Function.—To flex the forearm. This muscle is related with the brachial artery, which see.

Coraco-brachialis, (Fig. 225.)—*Arises* from the coracoid process, in common with the short head of the biceps, tendinous and fleshy. It descends, connected with the short head about three or four inches, along the inner arm to be inserted tendinous and fleshy into the inner side of the humerus, about its centre, and by an aponeurosis into the ridge leading to the internal condyle.

Function.—To raise the arm and draw it forward; it can also turn it outward. The musculo-cutaneous nerve penetrates this muscle. It is related with the brachial artery, which see.

The *brachialis anticus* or *internus* (Fig. 225) *arises* on either side of the insertion of the deltoid by two fleshy slips, which uniting descend, occupying the whole front of the lower part of the humerus, to be *inserted* into the coronoid process of the ulna by a strong tendon. This tendon is between the supinator radii longus and pronator radii teres, and passes beneath the tendon of the biceps and over the elbow-joint.

Function.—To bend the forearm and strengthen the elbow-joint. This muscle also, as the biceps, has a relation with the brachial artery, which see.

Triceps extensor cubiti—τρεις κεφαλαις, *three heads*—(Fig 226.)—This is a three-headed muscle, large and powerful,

and covering the whole back part of the humerus. It *arises* by its long head from the lower margin of the cervix scapulæ by a flat, short tendon. The *second head* comes from the outer and back part of the humerus, just below the greater tuberosity. The *third head*, called *brachialis externus*, but more properly internus, arises fleshy from the inner side of the humerus, near the insertion of the teres major. The three heads unite to form one muscle, which adheres strongly to the bone, and, ending in a broad tendon, is *inserted* into the posterior part of the olecranon process. A bursa is seen between the tendon and olecranon. *Function.*—To extend the forearm.

FIG. 226.

The Anconeus—ἀγκών, the elbow, (Fig. 230,) *arises* tendinous from the external condyle of the os-humeri. It is concealed partly by the triceps, and appears to be a portion of this muscle. It is *inserted* into the ridge of the upper extremity of the ulna connected with the olecranon.

Function.—To extend the forearm.

MUSCLES OF THE FOREARM.

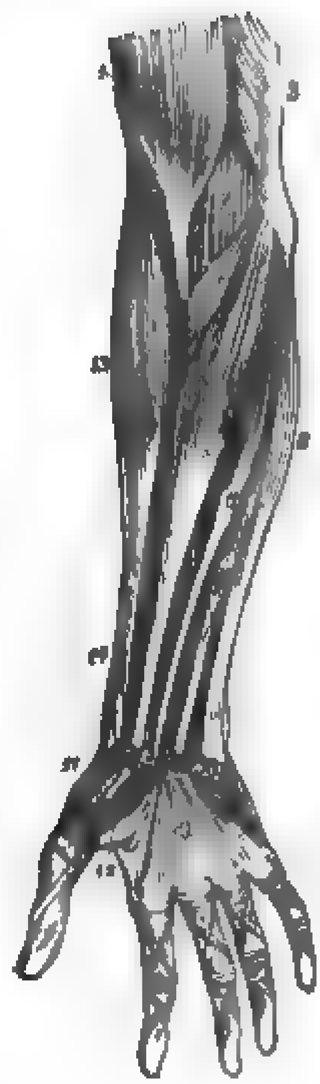
These comprise two divisions: 1st, Flexors and Pronators on the anterior forearm; 2d, Supinators and Extensors on the posterior.

The first division includes eight muscles, the *pronator radii teres*, *flexor carpi radialis*, *palmaris longus*, *flexor carpi ulnaris*, *flexor digitorum sublimis perforatus*, *flexor digitorum profundus perforans*, *flexor longus pollicis*, *pronator quadratus.*

FIG. 226 represents the Triceps Muscle. *a* External head of the triceps. *b* Its long head. *c* Its short head. *d* Olecranon process. *e* Radius. *f* Capsular ligament.

Pronator radii teres, (Fig. 227.)—*Dissection.*—Make an incision through the integuments along the centre of the forearm, from the elbow to the wrist; make a second incision transversely about the middle; turn off the integuments to the fascia, which latter dissect off separately, and this muscle will be exposed.

Fig. 227.



It *arises* fleshy from the internal condyle, and tendinous from the coronoid process of the ulna; its course is obliquely across the forearm to be *inserted* mostly tendinous into the middle of the back part of the radius. *Function.*—To pronate the hand by rolling the radius inward.

The flexor carpi radialis (Fig. 227) arises tendinous from the inner condyle, and fleshy from the upper part of the ulna, the intermuscular ligaments, and brachial fascia, forming a thick fleshy belly upon the ulnar side of the last muscle, and descends obliquely outward beneath the anterior annular ligament, through a groove in the os-trapezium, to be *inserted* into the fore part of the base of the metacarpal bone of the index finger. A bursa is seen between the tendon and os-trapezium. *Function.*—To flex the hand on the wrist.

This muscle is related with the radial artery, which see.

The palmaris longus (Fig. 227) arises from the inner condyle by a slender tendon, and fleshy from the intermuscular ligaments. Forming a short belly, it ends in a long slender tendon, which is *inserted* into the anterior annular ligament and palmar aponeurosis.

Fig. 227 represents the Superficial Muscles on the front of the Forearm. 1 Inferior portion of the Biceps. 2 Brachialis anticus. 3 Triceps. 4 Pronator radii teres. 5 Flexor carpi radialis. 6 Palmaris Longus. 7 Flexor sublimis perforatus. 8 Flexor carpi ulnaris. 9 Fascia palmaris. 10 Palmaris-brevis muscle. 11 Abductor-pollicis manus. 12 Flexor-brevis pollicis manus. 13 Supinator radii Longus. 14 Extensor-ossis metacarpi pollicis.

Function.—To flex the hand and make tense the palmar aponeurosis. This muscle is sometimes absent.

The flexor carpi ulnaris (Fig. 227) arises from the inner condyle tendinous, from the inner side of the olecranon process fleshy and tendinous, from the ridge upon the inner side of the ulna nearly its whole length, and from the fascia of the forearm. It forms a round tendon which is *inserted* into the pisiform bone, and base of the metacarpal bone of the little finger.

Function.—To flex the hand, and bring it towards the ulna. A bursa is seen between the tendon and os pisiforme. It is related with the ulnar artery, which see.

Flexor digitorum sublimis perforatus, (Fig. 227.) *Dissection.*—Remove the superficial muscles, and the flexor sublimis is brought to view.

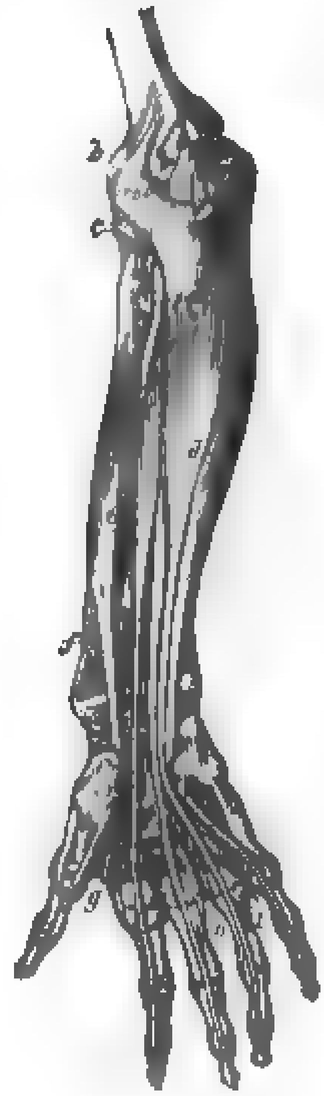
It *arises* from the inner condyle and coronoid process, tendinous and fleshy—fleshy from the tubercle of the radius and for three or four inches below the tubercle. Before the muscle reaches the wrist it divides into four tendons which pass to the palm of the hand beneath the anterior annular ligament, and then diverge to be *inserted* into the second phalanx of each finger. The tendons of this muscle are enclosed in a strong sheath, and at their intersection split into two, through which the tendon of the perforans passes.

Function.—To bend the second phalanges on the first. A large bursa surrounds the tendons of this muscle beneath the annular ligament.

The flexor digitorum profundus perforans (Fig. 228) *arises* beneath the sublimis, from the upper anterior surface of the ulna and inner portion of the interosseous ligament, fleshy—also fleshy from the coronoid process of the ulna and inner side of the olecranon process. A thick muscle is formed, which at the lower part of the arm divides into four flat tendons, which go beneath the annular ligament, enter the ligamentous sheaths on the fingers, pass through the slits in the perforatus, and are *inserted* into the last phalanx of each finger. *Function.*—To bend the last phalanges, and with the sublimis the hand.

The flexor longus pollicis (Fig. 228) *arises*, fleshy, beneath the flexor sublimis from the front part of the radius, below its tubercle, for about two-thirds of its extent, and from the radial portion of the interosseous ligament. It also has a tendinous origin from the inner condyle. Its tendon passes beneath the annular ligament, and between the two heads of the short flexor and sesamoid bones, to be *inserted* into the second phalanx of the thumb. A bursa is seen in connection with the tendon of this muscle.

Fig. 228.



Function.—To bend the last phalanx of the thumb.

The pronator quadratus (Fig. 228) *arises* from the anterior front surface of the lower extremity of the ulna, broad, tendinous and fleshy, passes transversely, and is *inserted* into the lower front surface of the radius. It is a small, square muscle, concealed by the flexor longus pollicis and flexor profundus.

Function.—To pronate the hand by rolling the radius inward.

The *muscles* on the *posterior* part of the *forearm* include the *supinators* and *extensors*, and comprise ten muscles, viz: the supinator radii longus, extensor carpi radialis longior, extensor carpi radialis brevior, extensor carpi ulnaris, extensor digitorum communis, supinator radii brevis, extensor ossis metacarpi pollicis manus, extensor minor pollicis, extensor major pollicis, indicator.

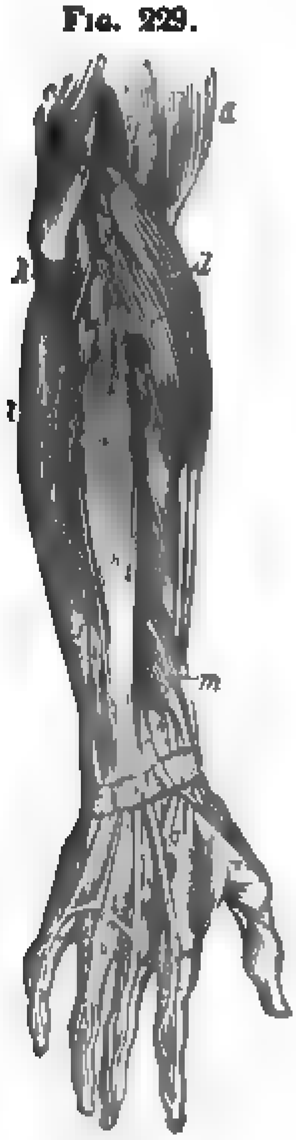
Supinator radii longus.—*Dissection.*—Make an incision along the middle of the back part of the arm and forearm. Make a second incision transversely about the middle of

Fig. 228 represents the deep muscles on the front of the Forearm. *a* Internal lateral ligament. *b* Capsular ligament. *c* Coronary ligament. *d* Flexor profundus perforans. *e* Flexor longus pollicis. *f* Pronator quadratus. *g* Adductor pollicis manus. *h* Lumbricales. *i* Interossei.

the forearm, turn aside the integuments and this muscle will be exposed.

It *arises* tendinous and fleshy from the ridge leading to the external condyle, commencing a little below the insertion of the deltoid, also from the inter-muscular ligaments.

FIG. 229.



A thick muscle is formed, which descends along the outer part of the elbow, and at the middle of the fore-arm terminates in a flat tendon, which is *inserted* upon the styloid side of the radius.

Function.—To supinate or turn the palm of the hand upward by rolling the radius outward.

Extensor carpi radialis longior (Fig. 229) *arises* from the external ridge of the os humeri, between the external condyle and supinator longus, tendinous and fleshy. A thick, short belly is formed, which about the middle of the radius ends in a flat tendon, which passes under the posterior annular ligament and over the wrist, to be *inserted* into the posterior part of the root of the metacarpal bone of the fore-finger. A bursa is seen surrounding the tendon of this muscle under the annular ligament, and another at its insertion.

Function.—To extend the wrist and hand.

Extensor carpi radialis brevior (Fig. 229) *arises* from the external condyle and external lateral ligament, tendinous and fleshy. A thick fleshy belly is formed, situated

FIG. 229 represents the muscles on the back of the forearm. *a* Inferior portion of the biceps. *b* Inferior portion of the brachialis anticus. *c* Inferior portion of the triceps. *d* Supinator radii longus. *e* Extensor carpi radialis longior. *f* Extensor carpi radialis brevior. *g* Tendinous insertions of these two latter muscles. *h* Extensor communis digitorum. *i* Auricularis, a portion of extensor communis. *j* Extensor carpi ulnaris. *k* Anconeus. *l* Flexor carpi ulnaris. *m* Extensor minor pollicis. *n* Extensor major pollicis. *o* Posterior annular ligament.

beneath the last muscle, which about the middle of the forearm ends in a flat tendon, which passes under the posterior annular ligament, in the same groove with the last muscle, and is *inserted* into the root of the metacarpal bone of the second or middle finger, on its back part.

Function.—To extend the wrist and hand.

The *extensor digitorum communis* (Fig. 229) *arises* from the external condyle, intermuscular ligament, and fascia, tendinous and fleshy. It descends to about the middle of the forearm, where it ends in four tendons which pass in a common groove of the radius under the posterior annular ligament, and on the back of the hand diverge to the roots of the fingers, where they are connected by cross slips, from whence they expand over the whole posterior part of all the phalanges of the fingers. The portion of this muscle going to the little finger receives the name of *auricularis*. A bursa is connected with the tendons of this muscle under the posterior annular ligament, and can be traced along these tendons to the base of the first phalanges.

Function.—To extend all the fingers.

The *extensor carpi ulnaris* (Fig. 229) *arises* tendinous from the external condyle, and fleshy from the intermuscular ligament and fascia; also fleshy from the back part of the ulna. It then descends, crossing obliquely the upper part of the radius and ulna, to end in a strong tendon, which passes through a groove on the back of the ulna, to be *inserted* into the base of the metacarpal bone of the little finger. A bursa is seen where the tendon passes through the groove of the ulna.

Function.—To extend the wrist and hand.

The *supinator radii brevis* (Fig. 230) *arises* tendinous and fleshy from the external condyle, external lateral and coronary ligaments, and from a ridge on the outer and upper part of the ulna. On removing the superficial muscles attached to the external condyle, it is seen surrounding the outer and upper part of the radius, and *inserted* into the tubercle of the radius, and into the oblique ridge leading to the insertion of the pronator teres.

Function.—To roll the radius outward.

Extensor ossis metacarpi pollicis manus, (Fig. 230.)—This muscle, called also *extensor primi pollicis*, *arises* fleshy from the posterior part of the ulna, just below the anconeus, from the interosseous ligament, and from the posterior part of the radius, below the supinator brevis. It ends in a round tendon which goes over the radial extensors, and through a groove on the styloid side of the radius, to be *inserted* into the os-trapezium and into the base of the metacarpal bone of the thumb. A bursa is seen where the tendon passes through the groove of the radius. *Function.*—To extend the metacarpal bone of the thumb.

FIG. 230.

The *extensor minor*, or *secundi pollicis*, (Fig. 230,) *arises*, tendinous and fleshy, from the posterior part of the ulna, below its middle, and from the interosseous ligament and radius. It descends and passes through the same groove of the radius with the last muscle, and is *inserted* into the posterior part of the first phalanx of the thumb. *Function.*—To extend the first phalanx of the thumb.

The *extensor major*, or *tertii pollicis*, (Fig. 230,) *arises*, above the middle of the ulna on its posterior part, from the interosseous ligament, and from the back of the radius. It ends in a tendon which passes through a separate groove of the radius, and goes to be *inserted* into the last phalanx of the thumb. A synovial membrane supplies its tendon at the wrist.

Function.—To extend the last phalanx of the thumb.

The *indicator* (Fig. 230) *arises* tendinous and fleshy from

FIG. 230 represents the Deep Muscles on the back of the Forearm. *a* Inferior portion of the humerus. *b* Olecranon process. *c* Body of the ulna. *d* Anconeus. *e* Supinator radii brevis. *f* Extensor ossis metacarpi pollicis *g* Extensor minor pollicis. *h* Extensor major pollicis. *i* Indicator. *j* First dorsal interossei.

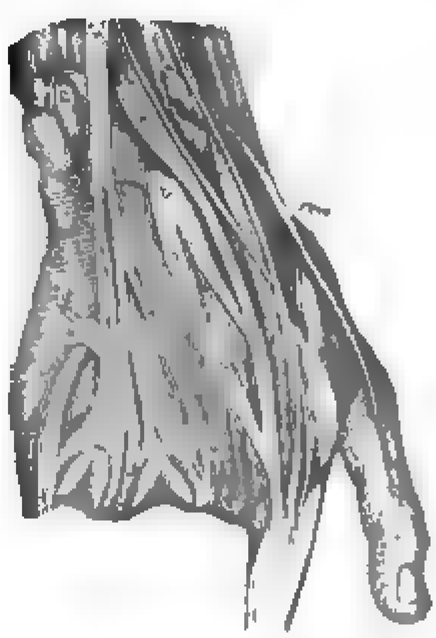
the middle of the back part of the ulna. It is a small muscle, concealed by the extensor ulnaris and communis. It ends in a tendon which passes along the same groove with the extensor communis, beneath the annular ligament, and is *inserted* with the tendon of that muscle into the back part of the second and third phalanges of the fore finger. *Function.*—To extend the fore finger.*

MUSCLES OF THE HAND.

Dissection.—Make an incision from the wrist along the middle of the palm to the base of the fingers; make a second incision crossing the first transversely about its centre, now reflect the integuments to either side, which will lead to the

* During the dissections in the winter of 1849–50, in the Baltimore College of Dental Surgery, a muscle was seen in connection with the indicator which seems to be entirely new, or at least not present in the dissections of anatomical writers, as we cannot find that they make any mention of it. We have thought the name of *Extensor Accessorius Indicis* not inappropriate. We will quote the explanation given of this muscle, from the April number, 1850, of the Medical Examiner. "It had its origin on the right hand by a delicate, tendinous membrane, from the radio-carpal articulation, behind the posterior annular ligament, and in the same groove with, and posterior to the tendons of the extensor communis and indicator, forming a fleshy bulb nearly the size of the plantaris of the leg. It soon, however, divided into two bellies—the one short and attached or *inserted* by a delicate tendon, into the tendon of the indicator, near the base of the metacarpal bone of the fore finger—the other larger, and connected also to the indicator, but near the articulation of the metacarpal bone with the first phalanx of the fore finger, and also by a narrow tendon, as seen in the drawing. On the left hand the muscle had but one belly, which ended in a tendon having a similar attachment and resemblance to the larger belly upon the right. Its *function* seems evidently to assist the indicator in the extension of the fore finger. Fig. 231 exhibits the muscle as seen from the dissection.

FIG. 231.



"*a a* Posterior annular ligament laid open. *b* Origin of the new muscle. *c* Its smaller belly. *d* Its greater belly. *h* Tendinous insertion of smaller belly. *g* Tendinous insertion of larger belly. *e* Indicator. *f* Extensor communis turned to one side to expose the origin of the new muscle. *i* Extensor longus pollicis."

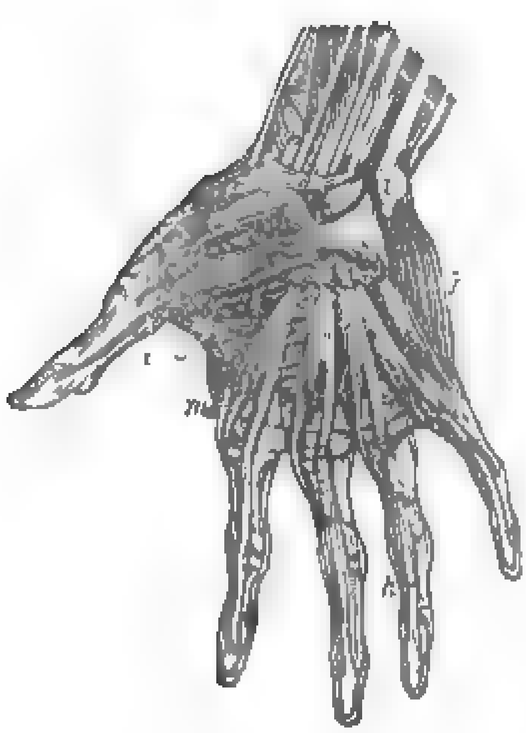
exposure of most of the muscles of the hand. For the fingers, extend the incision along the middle line of each.

The muscles of the hand are arranged into those of the thumb, the little finger, and its palmar and dorsal muscles.

MUSCLES OF THE THUMB.

The *abductor pollicis* (Fig. 227) arises from the anterior annular ligament, trapezium, and scaphoides, thin and broad, and is *inserted* into the radial side of the base of the first phalanx of the thumb.

Fig. 232.



Function.—To draw the thumb from the fingers.

The opponens pollicis (flexor ossis metacarpi pollicis, Fig. 232) arises from the annular ligament and trapezium, tendinous and fleshy, is beneath the last, and is inserted into the radial margin of the metacarpal bone of the thumb its whole length.

Function.—To draw the thumb to the fingers.

The *flexor brevis pollicis* (Fig. 232) arises by two heads, the first fleshy from the anterior annular ligament, trapezium and scaphoides, and is *inserted* into the outer sesamoid bone and base of the first phalanx of the thumb. The second head, which is internal and posterior, arises from the os magnum and base of the metacarpal bone of the middle finger, and is inserted into the inner sesamoid bone and base of the first phalanx of the thumb.

Fig. 232 represents the muscles of the Hand. *a* Annular ligament. *b b* Upper and lower attachments of the abductor pollicis. *c* Opponens pollicis. *d e* Flexor brevis pollicis, its two bellies. *f* Adductor pollicis. *g g* Lumbricales. *h* Point where the flexor profundus tendon passes through the flexor perforatus. *i* Flexor longus pollicis. *j* Abductor minimi digiti. *k* Flexor brevis minimi digiti. *l* Os pisiforme. *m* First dorsal interosseous.

Between the two heads the tendon of the flexor longus pollicis passes.

Function.—To bend the first phalanx of the thumb.

The *adductor pollicis* (Fig. 232) arises fleshy from the whole extent of the ulnar surface of the metacarpal bone of the middle finger. It is a broad, triangular muscle, situated beneath the lumbricales and tendons of the flexors sublimis and profundus; its fibres converge and are inserted tendinous into the inner base of the first phalanx of the thumb. *Function.*—To draw the thumb to the fingers.

The *abductor indicis* arises, fleshy and tendinous, from the ulnar portion of the metacarpal bone of the thumb, its whole extent, and the trapezium, and is inserted along the metacarpal bone and radial side of the first phalanx of the fore finger. *Function.*—To draw the fore finger from the rest, or adduct the thumb.

MUSCLES OF THE LITTLE FINGER.

The *abductor minimi digiti* (Fig. 232) arises fleshy from the annular ligament and pisiform bone, and is inserted, after running along the margin of the metacarpal bone into the ulnar side of the first phalanx of the little finger. *Function.*—To draw the little finger from the others.

The *adductor minimi digiti* arises fleshy from the annular ligament and os unciforme, and is inserted tendinous and fleshy into the front of the metacarpal bone of the fore finger its whole extent. *Function.*—To flex and draw the little finger to the others.

The *flexor brevis minimi digiti* (Fig. 232) *arises* fleshy from the annular ligament and unciform bone. It is beneath the abductor, and is *inserted* tendinous into the base of the first phalanx of the little finger.

Function.—To bend the little finger.

PALMAR MUSCLES.

The *palmaris brevis arises* from the anterior annular ligament and palmar aponeurosis. It is immediately below

the skin, covering the muscle of the little finger. Its fibres are separated and are *inserted* into the cellular tissue and integument.

Function.—To contract the skin of the palm and deepen the hollow of the hand.

The *lumbricales* (Fig. 232) are four in number, and situated below the anterior annular ligament. They each form a small fleshy belly which *arises* from the radial side of the tendons of the flexor profundus, and is *inserted* by a flat tendon into the posterior part of the first phalanx of each finger along with the tendinous expansion of the extensor communis.

Function.—To bend the first phalanges.

INTEROSSEOUS MUSCLES, (Figs. 232, 228.)

Anterior interossei.—These are three in number, and occupy the palmar portion of the hand. They *arise* fleshy and tendinous from the base and sides of the metacarpal bone, and are *inserted* into the base and posterior part of the first phalanx of the finger along with the tendinous expansion of the common extensor. The first palmar interosseous belongs to the fore-finger, the second to the ring-finger, and the third to the little finger.

Function.—Adductors of the fingers.

Posterior interossei.—Are situated on the back of the hand, and fill the interosseous spaces. They are four in number, and *arise* fleshy, by two heads from the base and sides of the metacarpal bones, and are *inserted* into the base of the first phalanges along with the tendinous expansion of the common extensor.

Function.—Abductors of the fingers.

SECTION II.

FASCIA OF THE SUPERIOR EXTREMITY.

The superior extremity is surrounded by an aponeurotic membrane from the shoulder to the hand, investing all its muscles externally, as well as sending processes between them, and separating each from the other.

The *shoulder* has three divisions of this general aponeurotic fascia; one covering the supra-spinatus muscle and attached to the margins of the supra-spinal fossa, called the *supra-spinous fascia;* a second, covering the infra-spinatus and attached to the margins of the infra spinal-fossa, called the *infra-spinous fascia.* Both of these fasciæ are strong and thick, and continued into the third division—the *deltoid fascia.* This latter covers the deltoid and pectoral muscles, is thin, and attached above to the spine of the scapula, acromion process, and external ends of the clavicle, while below it is traced into the next fascia belonging to the arm, and called—

Fascia Brachialis.—This fascia surrounds all the muscles of the arm to the elbow, sends off processes forming sheaths for the same, and above the condyles of the humerus, these processes separate the muscles on the front of the arm from those behind. They are attached to the ridge leading to the condyles, and are called *internal* and *external intermuscular ligaments.* At the end of the elbow the fascia brachialis is increased in strength by having a broad band, the bicipital aponeurosis, running into it. This band comes from the inner side of the tendon of the biceps, which with the fascia brachialis, is lost in the next fascia, called the *cubital fascia.* This is the fascia of the forearm, extending from the elbow to the wrists. It is thicker behind than before; surrounds and forms partitions for the several muscles, constituting at its upper portion intermuscular ligaments, and likewise separating the superficial from the deep layer of muscles, as well as affording attachment for many muscular fibres. At the wrist the cubital fascia forms two strong bands, the one in front, the other behind, called the *anterior* and *posterior annular ligaments.*

The *anterior* is a broad ligamentous band, extending across the wrist from the scaphoides and trapezium on the one side, to the unciform, cuneiform and pisiform bones on the other. This band confines and directs the flexor tendons of the fingers which pass beneath it.

The *posterior annular ligament* stretches from the styloid

margin of the radius on the one side, transversely to the styloid margin of the ulna and pisiforme bone on the opposite side. This ligament presents six trochleæ for the extensor tendons—one on the styloid side of the radius for the extensor ossis metacarpi and extensor minor pollicis, a second for the extensor carpi radialis longior and brevior, a third for the extensor major pollicis, a fourth for the extensor communis and indicator, a fifth for a branch of the extensor communis, and a sixth for the extensor carpi ulnaris.

The *aponeurosis palmaris* belongs to the hand, and covers its middle palmar portion. It is triangular in shape, and extends from the lower margin of the anterior annular ligament and tendon of the palmaris longus to the lower extremities of the metacarpal bones, where it divides into four portions, each of which bifurcates to be attached to its corresponding metacarpal bone, and gives passage to the vessels and nerves that go to the fingers. At this point the palmar fascia is strengthened by strong transverse fasciculi, forming arches, beneath which pass the tendons of the flexor muscles.

Vaginal ligaments of the fingers.—These are situated along the ulnar and radial margins of the phalanges, and are connected by transverse fibres so as to form a long tube or sheath, lined by synovial membrane, in which are contained the flexor tendons. These vaginal ligaments are of a fibro-cartilaginous character, and of great strength, and within them are observed little tendinous fræna passing from the first and second phalanges, and connecting with the tendons of the flexor profundus or sublimis.

SECTION III.

BLOOD VESSELS OF THE SUPERIOR EXTREMITY.

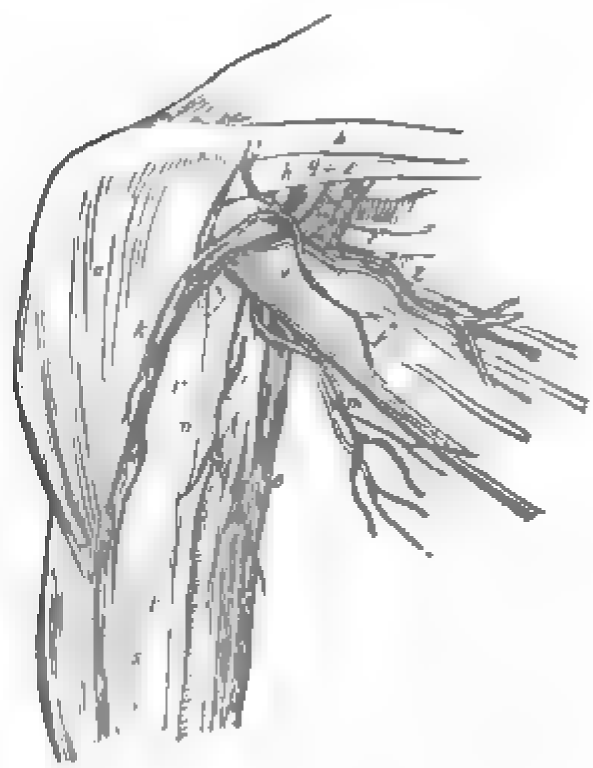
The *subclavian, axillary*, and *brachial arteries*, with their branches, are the sources of arterial supply of blood to the shoulder, arm, forearm, and hand, comprising the upper extremity. Those coming from the subclavian have been

described under the head of blood-vessels of the neck. (See Figs. 120, 153.)

ARTERIES OF THE SHOULDER.

Axillary artery, (*axilla*, the arm-pit.)—The axillary artery is the continued trunk of the subclavian, and receives this name at the lower border of the first rib, behind the subclavian muscle and clavicle; from this point it descends obliquely outward through the axillary space, where it is surrounded by a quantity of loose cellular and adipose tissue, containing many lymphatic glands, and terminates at the lower edge of the tendinous insertions of the latissimus dorsi and teres major muscles in the brachial artery.

FIG. 233.



In its course it is seen to pass behind the pectoralis major and minor, resting upon the first intercostal and serratus magnus, and having the coraco-brachialis on its outer or humeral side. The axillary vein ascends in front and to the inside. Above the little pectoral muscle, the brachial plexus of nerves is to the outside of this artery, behind the muscle, and surrounds it in such manner that it is embraced by the outer and inner roots of the median nerve, and a little lower down it has the median nerve in front, the radial behind, the ulnar and internal cutaneous on the

FIG. 233 represents the axillary artery and nerves. *a* Deltoid. *b* Clavicle. *c* Subclavius. *d* Pectoralis minor. *e* Second rib. *f* Axillary vein. *g* Axillary artery. *h* Space between brachial artery and brachial plexus of nerves. *i* Superior thoracic artery. *j* Thoracia media. *k* Thoracica acromialis, its descending branch. *l* Its acromial branch. *m* Thoracica inferior artery and nerve. *n* Thorcica alaris. *o* Internal cutaneous and ulnar nerves. *p* Median nerve. *q* External cutaneous nerves. *r* Coraco brachialis. *s* Biceps.

inside, and the external or musculo-cutaneous on the outside.

BRANCHES OF THE AXILLARY ARTERY, (Fig. 233.)

The *thoracica-acromialis*, or acromial thoracic artery, ascends above the pectoralis minor, and sends branches, called *thoracic*, to the pectoral and serratus magnus muscles, branches to the acromion, and a descending branch between the deltoid and great pectoral. It anastomoses with the supra scapular.

The *superior* or *short thoracic* often has a common origin with the thoracica-acromialis. It passes along the upper border of the little pectoral muscle, and supplies the pectoral muscles and mammary gland, anastomosing with the intercostal and mammary arteries.

The *inferior* or *long thoracic*, called also the *external mammary*, differs from the two last by arising below the lesser pectoral muscle. Sometimes it is a branch of the subscapular or acromial artery, or has a common trunk with them. It goes along the inferior edge of the great pectoral muscle, supplying it, the mammary gland, the great serratus muscle and the integuments, and anastomosing with the superior thoracic, the intercostal and the mammary arteries.

The *thoracica-axillaris*, frequently a branch of the thoracic, is distributed to the glands of the axilla.

The *subscapular artery*, (*scapularis inferior*,) the largest branch of the axillary, descends along the lower edge of the subscapularis muscle to the inferior angle of the scapula. In its course it sends branches to the axilla, and about an inch from its origin it gives off the *dorsalis scapulæ*, supplies the subscapularis, serratus magnus, and latissimus dorsi muscles, then winds around the inferior costa of the scapula to its dorsum, anastomosing with the superior scapular, and terminating upon the infra-spinatus muscle, where it is called *dorsalis inferior scapulæ*.

The *anterior circumflex artery* arises above the tendon of the teres major from the axillary. Sometimes it is a branch

of the posterior circumflex, and passes outward in front of the humerus, beneath the biceps, coraco-brachialis and deltoid, supplying these muscles, and sending a branch along the bicipital groove to the shoulder joint.

The *posterior circumflex artery* arises below the last, and is a larger branch. It goes round the neck of the humerus, between the latter and the long head of the triceps, to supply the shoulder joint and deltoid muscle. Sometimes it is a branch of the superior profunda.

ARTERIES OF THE ARM.

BRACHIAL ARTERY, (Fig. 234.)

The *brachial artery* is the continued trunk of the axillary, and extends from the lower margin of the tendinous insertions of the latissimus dorsi and teres major muscles, to a little below the bend of the elbow joint, where it divides into the radial and ulnar arteries.

Its course is along the inner edge of the coraco-brachialis and biceps muscles, resting upon the coraco-brachialis and brachialis anticus. It has the basilic vein in front, and the venæ comites on either side. The median nerve is also in front, though at the upper part it lies to the outside of the artery, and below to the inner side. It is covered by the fascia of the arm, and at the bend of the elbow by the bicipital aponeurosis and median basilic vein.

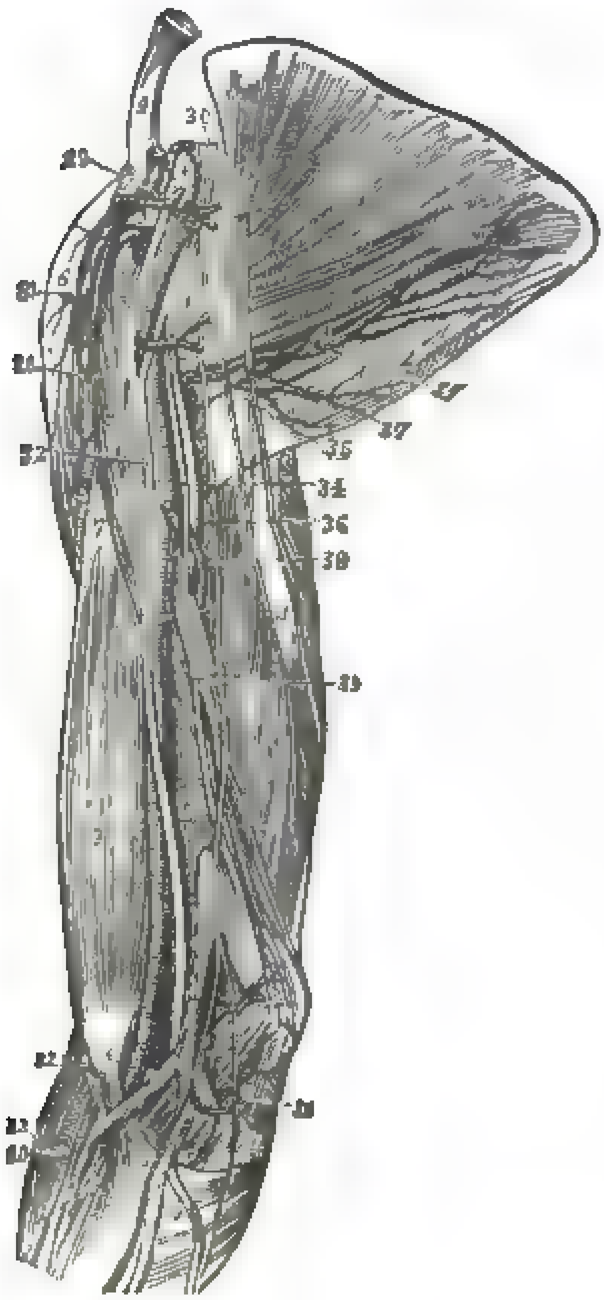
BRANCHES OF THE BRACHIAL ARTERY.

The *profunda superior* or *spiralis* comes from the brachial just below the teres-major, winds round the back part of the humerus along with the musculo-spiral nerve, between the second and third heads of the triceps, to the external condyle, where it anastomoses with the radial recurrent, and sends a descending branch along the triceps to the olecranon.

The *nutritious artery* comes from the brachial about the middle of the arm, and enters the medullary foramen of the humerus to supply its lining membrane.

The *profunda inferior* or *minor* arises opposite the tendon of the coraco-brachialis below the superior profunda, and passes inward and downward to the inner condyle along with the ulnar nerve, and anastomoses with the ulnar recurrent. It is sometimes a branch of the superior profunda.

FIG. 234.



The *anastomotica magna* comes off from the brachial about two inches above the joint, rests upon the brachialis anticus, and passing inward above the inner condyle, supplies the adjacent muscles, and anastomoses with the ulnar recurrent and inferior profunda.

Muscular branches are sent off in the course of the artery to the various muscles.

Varieties in the bra-

FIG. 234 represents the Brachial Artery and Nerves. 1 Subscapularis muscle. 2 Teres major. 3 Dorsalis scapulæ branch of the subscapular artery. 4 Clavicle. 5 Coracoid process. 6 Deltoid. 7 Insertion of pectoralis major. 8 Coraco brachialis. 9 Biceps. 11 Long head of triceps. 12 Its short head. 13 Axillary artery. 14 Brachial artery. 15 Bicipital aponeurosis. 16 Long thoracic artery. 17 Inferior profunda. 18 Anastomotica magna. 19 Anterior and posterior ulnar veins. 20 Median vein. 22 Median cephalic. 23 Radial vein. 24 Median basilic. 26 Basilic vein. 27 Subscapular artery. 28 External or musculo-cutaneous nerve. 29 Thoracica acromialis artery. 30 Brachial plexus. 31 Cephalic vein. 32 Median nerve. 33 Ulnar nerve. 34 Musculo-spiral or radial nerve. 35 Circumflex nerve. 36 Internal cutaneous nerve. 37 Intercosto humeral nerve. 38 Superior profunda artery. 39 Anterior branch of internal cutaneous nerve. 40 Branches of external cutaneous nerve.

chial artery are chiefly noticed in the high division of its radial and ulnar branches, which may occur at any point between the elbow and the axilla.

ARTERIES OF THE FOREARM.

RADIAL ARTERY, (Fig. 235.)

The *radial artery* seems to be the continued trunk of the brachial, and extends from the bend of the elbow to the wrist. At its upper part, it is between the supinator radii longus and pronator radii teres. It descends along the radial side of the forearm, covered only by the skin and fascia, crosses over the tendon of the biceps and pronator teres; and at its lower part lies between the supinator longus and flexor carpi radialis. Here it passes outward on the back of the wrist behind the extensor tendons of the thumb, and dips down into the palm of the hand, between the roots of the metacarpal bones of the thumb and fore finger, where it terminates in the *arcus profundus*, or deep palmar arch. The radial artery in its course is accompanied by venæ comites, and by the radial nerve as far as the middle of the forearm.

BRANCHES OF THE RADIAL ARTERY.

The *recurrens radialis* arises opposite the neck of the radius, passes upward and outward to the external condyle, and anastomoses with the profunda superior.

Muscular branches are sent off in its course to the various muscles, supinators, and flexors.

The *superficialis volæ* comes off as the artery is curving upon the wrist, and supplies the ball of the thumb.

The *dorsalis carpi* arises next in order and supplies the interosseous muscles of the back of the hand.

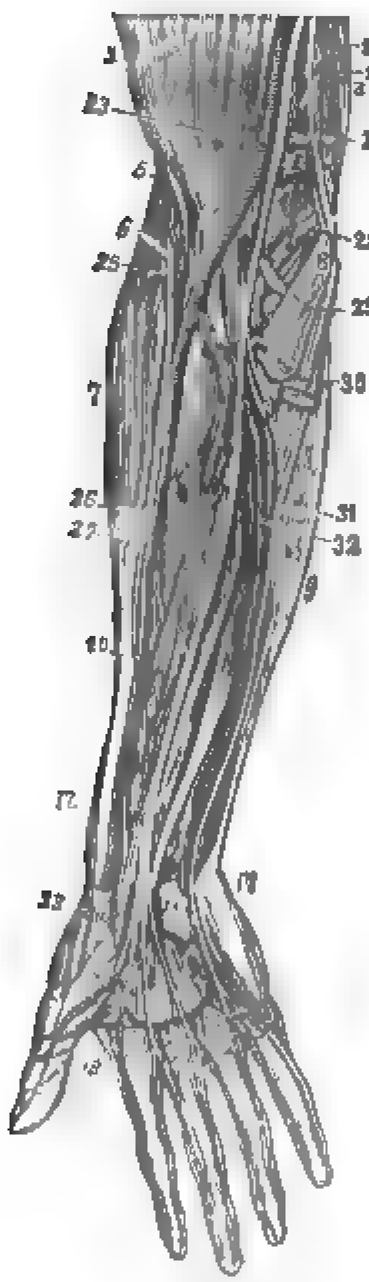
The *radialis indicis* comes off at the root of the metacarpal bone of the thumb, and goes along the radial side of the fore finger to its extremity.

The *magna pollicis* arises at the same point with the last, and at the head of the metacarpal bone of the thumb divides into two branches, which supply each side of the thumb to its extremity.

THE ULNAR ARTERY, (Fig. 235.)

The ulnar artery is larger than the radial, and forms the remaining terminal branch of the brachial; it extends from the bend of the elbow to the wrist, where it terminates in the *arcus sublimis*, or superficial palmar arch. At its upper end it crosses the arm obliquely, covered by the pronator teres, flexor sublimis, flexor radialis, and palmaris longus, to the middle of the forearm, where it is traced along the radial margin of the flexor carpi ulnaris to the wrist. Here it passes over the anterior annular ligament into the palm. It is attended by venæ comites, and the ulnar nerve.

Fig. 235.



BRANCHES OF THE ULNAR ARTERY.

The *recurrens ulnaris anterior* comes from the ulnar artery about the tubercle of the radius, and ascends in front of the inner condyle.

The *recurrens ulnaris posterior* ascends behind the inner condyle, and with the anterior, anastomoses with the anastomotica and inferior profunda.

Fig. 235 represents the Radial and Ulnar Arteries. 1 Biceps. 2 Its tendon. 3 Triceps. 4 Anastomotica magna artery. 5 Brachialis anticus. 6 Radial or musculo-spiral nerve. 7 Supinator longus. 8 Internal condyle. 9 Flexor carpi ulnaris. 11 Interosseous artery. 12 Median nerve. 13 Flexor sublimis digitorum. 14 Annular ligament divided. 15 Superficial palmar arch. 16 Superficialis volæ. 17 Branch of ulnar nerve. 18 Radialis indicis artery. 19 Anterior ulnar recurrent artery. 20 Tendon of supinator longus. 21 Inferior profunda artery. 22 Ulnar nerve. 23 Brachial artery. 24 Median nerve. 25 Recurrent radial artery. 26 Radial nerve 27 Radial artery. 28 Pronator radii teres. 29 Flexor carpi radialis. 30 Palmaris longus—these three latter muscles are cut across. 31 Ulnar nerve. 32 Ulnar artery. 33 Branch of the radial nerve.

The *interosseous artery* arises just below the last, and divides after a short course into two branches, an *anterior* and a *posterior*.

The *anterior interosseous artery* descends in front of the interosseous ligament behind the deep flexors to the pronator quadratus, where it penetrates this ligament to the back of the wrist, and anastomoses with the radial and posterior interosseous.

The *posterior interosseous artery* is the smaller branch, and sometimes arises as a separate trunk; it soon passes through the interosseous ligament to the back of the arm, and then descends to supply the extensor muscles. At its upper end it gives off a recurrent branch to the posterior part of the elbow, which anastomoses with the recurrens radialis and ulnaris.

Muscular branches, numerous and irregular, are given off in its course.

The *dorsalis carpi ulnaris* comes off at the lower end of the ulna, and winds beneath the flexor ulnaris tendon to the back of the wrist, where it anastomoses with the radial and interosseal, to supply the carpus, metacarpus, and phalanges.

Varieties.—The ulnar artery may arise from the axillary, the interosseal from the radial, brachial, or axillary. Indeed it is difficult to say what will be the distribution of the arteries of the forearm until it is examined.

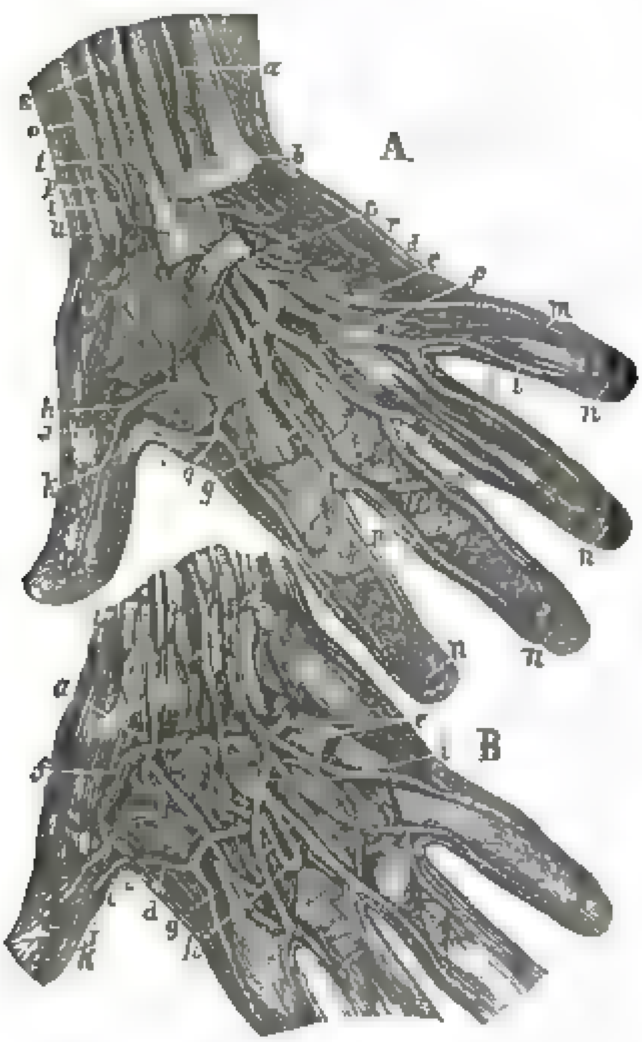
ARTERIES OF THE HAND, (Fig. 236.)

The *arcus sublimis* or *superficialis* is the continued trunk of the ulnar artery, and extends from the lower border of the annular ligament across the palm of the hand to the thumb, to anastomose with the radial; after supplying the muscles of the palm, it sends deeply a larger branch, called *cubitalis manus profunda*, to unite with the arcus profundus.

It next sends off the *digital arteries*. These are four in number; the first goes on the ulnar side of the little finger; the others proceed to the heads of the metacarpal bones,

where they each divide and run along the adjacent sides of opposing fingers to their extremities, excepting the radial side of the index finger which is supplied from the radial.

Fig. 236.



The *arcus profundus* is one of the terminating branches of the radial; it extends from the root of the metacarpal bone of the thumb, deep into the palm of the hand, behind the flexor tendons, and close to the metacarpal bones, forming an arch across the hand from the radial to the ulnar side, to anastomose with the superficial arc. In its course it gives off branches to the interosseous muscles, and perforating branches through the interosseous spaces to the dorsal interossei. The arteries of the hand are subject to great variety.

Fig. 236, A represents the arcus superficialis. *a* Ulnar artery. *b* Its relation with the annular ligament. *c* Ulnar artery in the palm of the hand. *d e f g h i* Its digital branches. *j* Place of anastomosis with the arcus profundus. *k* Point where the radial artery terminates. *l l* Digito radial arteries. *m m* Digito ulnar arteries. *n n* Place where the radial and ulnar digital branches anastomose. *o* Radial artery. *p* Its place of turning on the back of the hand. *q* Its last branch, called radialis indicis. *r* Termination of arcus profundus. *s t* Muscular branches of the radial at the wrist. *u v* Superficialis volæ.

Fig. 236, B represents the arcus profundus. *a* Point where the radial artery enters the palm of the hand. *b* Anastomosing branch. *c* Branch on the side of the thumb. *d* Branch to the fore finger. *e* Anastomosis of arcus profundus with an ulnar digital branch. *f* Arteria magna pollicis. *g h i j k l* Interosseous branches.

VEINS OF THE SUPERIOR EXTREMITY.

The veins of the superior extremity begin at the extremity of the fingers, and are divided into the *superficial* and *deep*.

The superficial are the *cephalic*, *basilic*, and *median veins*.

The *cephalic* is formed on the back of the wrist by the union of the dorsal veins of the hand. It ascends along the radial side of the forearm to the elbow, and thence upward along the outer side of the biceps to the groove between the pectoral and deltoid muscles, where it dips down to join the axillary vein just below the clavicle.

The *basilic* begins at the lower extremity of the ulna by several branches, one of which from the little finger is called *vena salvatella*. It ascends along the ulnar side of the forearm to the inner condyle, thence to the inner side of the arm, where it penetrates the fascia, gets in front of the brachial artery, and joins the brachial vein. The basilic often ascends the forearm by two trunks, an anterior and posterior, which unite into one just below the elbow-joint.

Fig. 237.

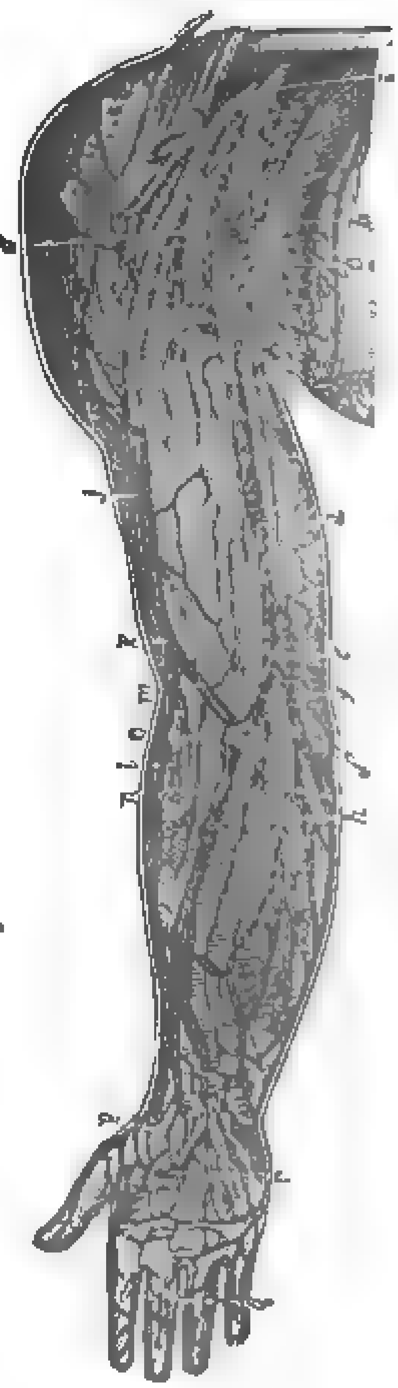


Fig. 237 represents the veins of the Superior Extremity. *a* Axillary artery. *b* Axillary vein. *c* Brachial vein. *dd* Basilic vein, a portion under and a portion without the brachial fascia. *e* Union of median basilic with the basilic. *f* Posterior basilic. *g* Anterior basilic. *i* Termination of cephalic vein in the axillary. *j* Cephalic beneath the fascia. *k* Union of median cephalic with the cephalic vein. *l* Cephalic vein, its inferior portion. *m* Median cephalic. *n* Median vein. *o* Anastomosis of superficial and deep veins. *p* Branches of cephalic vein to the thumb. *q* Digital vein. *r* Palmar veins.

uted to the subscapular, latissimus dorsi, and teres major muscles.

The *internal cutaneous nerve* (Fig. 239) arises from the lower part of the plexus, in common with the inner head of the median, and is among the smallest of the nerves supplying the arm. It descends in company with the basilic vein, and above but near the elbow it divides into an *external* or *anterior*, and *internal* or *posterior* branch. Before this division, the nerve sends filaments through the fascia to the biceps, the inner portion of the triceps, and the integuments. The *external* branch goes in front, and sometimes behind, the median basilic vein. Sometimes there is a branch of it both in front and behind the vein; it descends over the bend of the elbow to the forearm, as low as the wrist, supplying the integuments in its course. The *internal* branch goes to the inner condyle, and separates into filaments, some of which go in front, but the most pass on the back part of the forearm, to supply chiefly the integuments.

Fig. 239.

The *lesser internal cutaneous*, or *nerve of Wrisberg*, (Fig. 239,) comes also from the lower part of the plexus, and is considered an accessory branch to the internal cutaneous. It is a small, long branch, passing down the back of the arm, and at the middle of the latter going through the

Fig. 239 represents the Cutaneous Nerves of the Elbow Joint. *a* Radial vein. *b* Cephalic vein. *c* Anterior ulnar vein. *d* Posterior ulnar vein. *e* Common ulnar vein. *f* Basilic vein. *g* Where basilic vein pierces the fascia. *h* Median vein. *i* A deep vein uniting with the median. *j* Median cephalic. *k* Median basilic. *l* Fascia. *m* Aponeurotic band from the tendon of the biceps. *n* Cutaneous portion of musculo-cutaneous nerve. *o* Internal cutaneous nerve. *p* Lesser internal cutaneous, or nerve of Wrisberg. *q* External cutaneous branch of musculo-spiral nerve.

fascia, to be distributed to the integuments about the elbow. It communicates with filaments of the internal cutaneous and musculo-spiral nerves, and in the axilla with the first intercosto-humeral nerve.

The *external cutaneous*, (Fig. 239,) called also *musculo-cutaneous*, or *perforans Casserii*, comes from either the upper or middle division of the plexus, is larger than the last, and descends by perforating the coraco-brachialis muscle. It then passes outward between the biceps and brachialis anticus, distributing filaments to these muscles, and at the bend of the elbow it becomes superficial, joins the cephalic vein, and descends to the wrist, where it divides into branches, some of which are anterior, supplying the ball of the thumb, others posterior, distributed to the back of the hand.

The *circumflex* or *articular nerve* arises from the lower part of the plexus, and passes along with the posterior circumflex artery, around the neck of the humerus, between the teres minor and major muscles, to be distributed on the inner surface of the deltoid. This nerve encircles the neck of the humerus by a superior and inferior branch.

The *median* or *brachial nerve*, (Fig. 235,) so called from being between the ulnar and radial nerves, arises by two roots and descends the arm in front of the brachial artery, inclining however above rather to the outer side of the artery, and below to its inner or ulnar side. It goes along the inner edge of the biceps muscle, and at the bend of the elbow is seen on the ulnar side of the supinator longus beneath the bicipital aponeurosis. Here it perforates the pronator teres, and descends the middle of the forearm, between the superficial and deep flexors, to the anterior annular ligament of the wrist, beneath which it passes to the palm of the hand, there to terminate in digital branches.

The median nerve gives off at the bend of the elbow *muscular branches*, supplying most of the flexors and pronators; next, the *interosseous nerve*, a considerable branch which accompanies the anterior interosseal artery, supplying the deep flexors in its course. At the pronator

quadratus, after supplying it, it goes through the interosseous ligament to the back of the hand. At the wrist the median sends a branch over the annular ligament to the integuments on the ball of the thumb and palm of the hand, called the *superficial palmar.*

In the palm, as stated, the median divides into *digital* branches, which are five in number. The first two go along on either side of the thumb, the third along the radial side of the fore finger, the fourth divides and runs along the adjacent sides of the fore and middle fingers, and the fifth also divides to supply the adjacent sides of the middle and ring fingers. A muscular branch is also seen going from the median to the muscles of the ball of the thumb. These digital nerves all accompany the digital arteries.

The *ulnar nerve* (Fig. 235) comes from the lower part of the plexus and descends along the anterior and internal part of the triceps to the inner condyle, between which and the olecranon it passes. It also goes between the two heads of the flexor carpi ulnaris, and gets to the front of the forearm, along the ulnar edge of which it descends to the wrist; here it passes over the annular ligament, adjacent to the pisiforme bone, and in the palm of the hand divides into a superficial and deep branch.

To the various muscles along its course *muscular* branches are given off. A little above the wrist it sends off the *dorsalis carpi,* which gets to the back of the wrist beneath the tendon of the flexor ulnaris, to supply the integuments on the back of the hand and the two last fingers. The *superficial terminating* branch of the ulnar divides so as to supply both sides of the little finger and the ulnar side of the ring finger. There is also a branch communicating with the median. The *deep branch* dips beneath the flexor tendons to form the deep palmar arch and to supply the interossei muscles.

The *radial* or *musculo-spiral nerve* (Fig. 235) comes from different parts of the axillary plexus. It is a large nerve, and descends obliquely outward round the humerus along with the superior profunda artery, between the triceps

muscle and the bone, to the outer side of the humerus, between the triceps and the brachialis anticus muscles. At the bend of the elbow it divides into an *anterior* and *posterior* branch.

The anterior, called *ramus superficialis anterior*, appears to be the continued trunk of the radial, accompanies the radial artery to a little below the middle of the radius, and then goes beneath the tendon of the supinator longus to the back of the hand, where it becomes cutaneous and divides into two branches, the one supplying the back of the hand, the thumb, the fore and middle fingers; the other going to the muscles and integuments of the thumb.

The *posterior branch* of the radial, called also *posterior interosseal*, or *ramus profundus dorsalis*, gets to the back of the forearm, accompanies the posterior interosseal artery, and supplies the extensor muscles.

Above the external condyle, a short distance, a branch called *ramus superficialis dorsalis* is given off. After sending filaments to the supinators and extensors at the outer condyle, it becomes cutaneous, and descends the forearm along the radial margin of the supinator longus to the back of the hand.

The *intercosto-humeral nerves* (Fig. 234) are described as two branches, one coming from the second, the other from the third thoracic. The first is seen beneath the second, the other beneath the third rib. The first is connected with the lesser internal cutaneous, and supplies the axilla, its skin and glands; the other descends as low as the elbow, chiefly supplying the integuments on the back of the arm.

SUMMARY OF THE MUSCLES OF THE SUPERIOR EXTREMITY.

MUSCLES OF THE SHOULDER.

Deltoid.	**Teres-minor.**
Supra-spinatus.	**Teres-major.**
Infra-spinatus.	**Subscapularis.**

MUSCLES OF THE ARM.

ON THE FRONT.	ON THE BACK.
Biceps flexor cubiti.	**Triceps extensor cubiti.**
Coraco-brachialis.	**Anconeus.**
Brachialis anticus.	

MUSCLES OF THE FOREARM.

ON THE FRONT.	ON THE BACK.
Pronator radii teres.	Supinator radii longus.
Flexor carpi radialis.	Extensor carpi radialis longior.
Palmaris longus.	Extensor carpi radialis brevior.
Flexor carpi ulnaris.	Extensor carpi ulnaris.
Flexor sublimis digitorum perforatus.	Extensor communis digitorum.
Flexor profundus perforans.	Extensor ossis metacarpi pollicis.
Flexor pollicis longus.	Extensor minor pollicis.
Pronator quadratus.	Extensor major pollicis.
	Indicator.
	Supinator radii brevis.

MUSCLES OF THE HAND.

Palmaris brevis.	Abductor minimi digiti.
Abductor pollicis manus.	Flexor brevis minimi digiti.
Opponens pollicis.	Adductor minimi digiti.
Flexor brevis pollicis.	Lumbricales.
Adductor pollicis.	Interossei.

INFERIOR EXTREMITY.

THE INFERIOR EXTREMITY COMPRISES BONES, LIGAMENTS, MUSCLES, FASCIA, BLOOD-VESSELS, AND NERVES, AND WILL BE EXAMINED UNDER THESE SEVERAL HEADS RESPECTIVELY.

CHAPTER I.

THE BONES AND LIGAMENTS.

THE bones are arranged into those of the *thigh*, *leg*, and *foot*, which, with the ligaments, constitute the passive organs.

SECTION I.

BONE OF THE THIGH—OS FEMORIS.

The *femur* is the only bone belonging to the thigh, and is the longest one in the skeleton. Situated between the pelvis and leg obliquely, it presents rather a twisted appearance, is broad below, contracted and cylindrical in the centre, and thick above. It is composed of a *body* and two *extremities*.

The *body* is convex and smooth in front, concave and

rough behind. The front is covered with muscles. The posterior part presents a rough line running the length of the bone, called the *linea aspera*. This line has an external and internal ridge. To the former is attached the gluteus maximus, the short head of the biceps, and the vastus externus muscles; to the latter the vastus internus, triceps, adductor, and pectineus. These ridges widen below and go to the condyles; above they lead to the trochanters. In the linea aspera, about its middle, is seen the foramen for conducting the nutritious artery.

A Fig. 240. B

The superior extremity of the femur presents a smooth, rounded form, called the *head*. It looks upward and inward, and has a rough depression just below its centre for the attachment of the ligamentum teres. Just below the head, the bone contracts and forms the *neck*, which connects with the body or shaft by an angle more or less obtuse, varying according to the sex, being longer and more oblique in the male than in the female.

External to the neck there is a large process, called the

Fig. 240, A represents an anterior view of the Femur. *a* Pit for attachment of round ligament. *b* Head. *c* Neck. *d* Trochanter major. *e* Trochanter minor. *f* Point of attachment of the capsular ligament. *g* Shaft or body. *h* External condyle. *i* Internal condyle. *j* Point for the patella.

Fig. 240, B represents a posterior view of the Femur. *a* Depression for round ligament. *b* Head. *c* Pit for the rotatory muscles. *d* Trochanter major. *e* Trochanter minor. *f* Point of attachment of tendon of gluteus maximus. *g g* Linea-aspera. *h* Point of attachment for the gastrocnemius. *i* External condyle. *j* Point of attachment of anterior crucial ligament. *k* Depression for posterior crucial ligament. *l* Point of attachment of internal lateral ligament.

trochanter major, which is continuous with the outer side of the shaft. It is a broad, rough, convex eminence, over which glides the tendon of the gluteus maximus muscle; to its summit is attached the gluteus medius; to its anterior surface the gluteus minimus, and to its posterior the quadratus femoris. Internally this trochanter presents at its base a pit or fossa in which are inserted the tendons of the rotator muscles of the thigh, as the pyriformis, gemelli, and obturators externus and internus. On the inner and posterior side of the upper part of the shaft is the *trochanter minor*. This is a conical projection below the great trochanter, and gives insertion to the tendons of the psoas magnus and iliacus internus muscles. Between the two trochanters are seen two lines, one in front the other behind, called *inter-trochanteric lines*, to which are attached the quadratus femoris muscle and the capsular ligament.

The lower extremity of the femur is large and broad, and is divided into an external and internal condyle separated by an intervening notch. Each condyle presents an outer and an inner face. The *external* is larger and more prominent; its articular surface is higher and broader. Its outer surface is rough for the attachment of the external lateral ligament; its inner surface is also rough, and gives attachment at its posterior part to the anterior crucial ligament. The *internal condyle* is longer and narrower than the external. To its inner side are attached the internal lateral ligament and adductor tendon, and to its outer side the posterior crucial ligament. Both condyles have a greater convexity behind than before. The inferior extremity presents many foramina for the passage of vessels.

The body of the femur is composed of compact tissue traversed by a medullary canal, while its extremities are cellular.

Its *development* is from five points; one for the shaft, one for each extremity, and one for each trochanter. It is among the first of the long bones to ossify, ossification being observed at the close of the second month. In the condyles ossification takes place during the ninth month;

in the head at the close of the first year; in the great trochanter during the third and fourth year, and in the lesser trochanter about the thirteenth or fourteenth year. The different processes are united about the twentieth year.

The femur is *articulated* with the acetabulum, tibia and patella.

SECTION II.

BONES OF THE LEG.

1. Tibia. 2. Fibula. 3. Patella.

The *tibia* is situated on the inner and anterior part of the leg, and is next to the femur in length. Its form is triangular, and it consists of a *body* and two *extremities*.

FIG. 241.

The body presents three edges—one anterior, called the *crest* or shin, which is superficial and sharp; a second internal and round; and a third external for the attachment of the interosseous ligament. It also presents three surfaces—one internal and superficial; a second external and concave; and a third posterior, covered by muscles. At the upper part of the body is the foramen for the nutritious artery.

The *superior extremity* of the tibia is large and somewhat oval in shape. Its femoral surface is smooth and covered with cartilage for articulation. It is divided by a spine into an *external* and *internal surface*. The former articulates with the external condyle, and is circular and superficial; the latter with the internal condyle, and is oval and deeper The *spine* is elevated nearer the posterior than the

FIG. 241 represents an anterior view of the *Tibia* and *Fibula*. *a* Shaft of the tibia. *b* Inner tuberosity. *c* Outer tuberosity. *d* Spinous process. *e* Tubercle of tibia. *f* Inner surface of the shaft. *g* Inferior end of the tibia. *h* Internal malleolus. *i* Shaft of the fibula. *j* Superior extremity of the fibula. *k* External malleolus.

anterior margin, and gives attachment in front and behind it to the anterior and posterior crucial ligaments. Just below the articular surface the tibia presents on either side a prominence; the inner is for the attachment of the internal lateral ligament and tendon of the semi-membranosus muscle; the outer has an articular surface for the head of the fibula. On the anterior part of the head of the tibia a *tubercle* is seen for the insertion of the ligamentum patellæ. At its upper part there is a bursa. On the inner side of this tubercle a concavity is seen for the insertion of the tendons of the sartorius, gracilis, and semitendinosus muscles.

The *inferior* or *tarsal* extremity of the tibia is much smaller than the upper. Its lower surface is smooth, concave and rather quadrilateral, for articulating with the upper surface of the astragalus. Internally there is a thick vertical process, called the *internal malleolus*, which has its outer surface smooth to articulate with the side of the astragalus, and its inner rough for the attachment of the internal lateral ligament. On its posterior ridge there is a groove through which pass the tendons of the tibialis posticus and flexor communis. On the external margin of the lower extremity of the tibia there is a smooth triangular surface for articulation with the lower end of the fibula.

The *structure* of the tibia, like that of all the long bones, is compact in the body and cellular in the extremities.

Its *development* is from three points—one for the body, and one for each extremity. Ossification is seen soon after that of the femur. Soon after birth it takes place in the head of the bone, and in the second year in the inferior extremity. The bone is complete about the twenty-fifth year.

It is *articulated* with the femur, fibula, and astragalus.

The *fibula* (Fig. 241) is a slender bone, situated upon the outer side of the tibia, and is nearly the same length with that bone. It consists of a body and two extremities.

The *body* is triangular and somewhat twisted. It has three angles and three surfaces. The angles or ridges are *anterior*, *posterior* and *internal*. The surfaces are *external*,

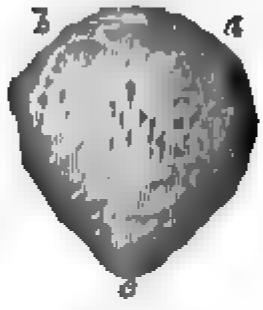
internal and *posterior*. The *external* gives origin to the peronei muscles. The internal is divided by a ridge to which the interosseous ligament is attached; and the surface in front of the ridge is for the origin of the extensor muscles; that behind the ridge for the tibialis posticus. The *posterior surface* is covered by the soleus, and below by the flexor pollicis pedis.

The *superior extremity* or head is circular and small, and presents a slight cavity for articulating with the external head of the tibia. Its outer surface gives attachment to the external lateral ligament and tendon of the biceps muscle. The *inferior* or *tarsal* extremity is larger than the upper, and ends in a long, oval projection, termed the *external malleolus*. This process internally is smooth and triangular for articulating with the astragalus; a little above it is rough for connecting with the tibia; posteriorly it is grooved for the tendons of the peronei muscles; exteriorly it is rough and superficial and gives attachment to ligaments. The centre of the shaft contains the nutritious foramen.

The *structure* is the same as that of the tibia, being compact in its shaft and cellular in its extremities.

Its *development* is by three points; one for the shaft, and one for each extremity. Ossification begins soon after it does in the tibia; during the second year the lower epiphysis begins to ossify, and in the fourth or fifth year the upper epiphysis, the bone being completed about the twenty-fifth year. The fibula is *articulated* with the tibia and astragalus.

Fig. 242.



The *patella* or *rotula* is situated in front of the knee joint, and is regarded as a sesamoid bone, developed in the tendon of the extensor femoris muscle. Its shape is triangular; its base above receives the tendons of the extensor muscles; its apex below is pointed,

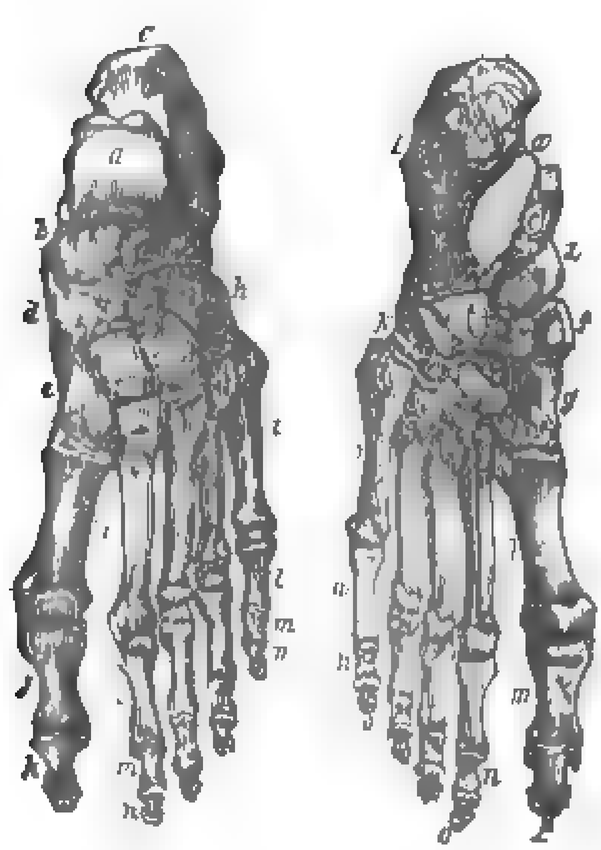
Fig. 242 represents the Patella. *a b* Point of attachment of the tendon of the triceps-extensor and femoris muscle. *c* Point of attachment of the ligamentum patellæ.

and has the ligamentum patellæ attached to it. Its anterior surface is convex, perforated with foramina, and has a bursa. Its posterior is smooth, covered with cartilage, and doubly concave for articulation with the condyles of the femur. It is *developed* by a single point, during the third year.

SECTION III.

BONES OF THE FOOT, (Fig. 243.)

A Fig. 243. B



These are divided into the *tarsus*, *metatarsus*, and *phalanges*.

The *tarsus* consists of seven bones—the *astragalus*, *os calcis*, *os naviculare*, *internal*, *external* and *middle cuneiform*, and the *cuboid bone*.

The *astragalus* (ἀστράγαλος, a die) is situated between the tibia and os calcis, occupying the upper portion of the instep. Its upper surface is smooth, and arched for articulating with the tibia. Its lower surface presents two artic-

Fig. 243, A represents the Dorsal surface of the Foot. *a* Astragalus. *b* Point of articulation with the naviculare. *c* Os-calcis. *d* Os-naviculare, or scaphoides. *e* Internal cuneiform. *f* Middle cuneiform. *g* External cuneiform. *h* Cuboid bone. *i* Metatarsal bones. *j* First phalanx of the great toe. *k* Second phalanx of the great toe. *l m n* First, second, and third phalanges of the other toes.

Fig. 243, B represents the Plantar surface of the Foot. *a* Lesser apophysis of the calcis. *b* Exterior edge of calcis. *c* Groove for the tendon of the flexor longus pollicis pedis. *d* Anterior portion of astragalus. *e* Naviculare. *f* Its inner side and tuberosity. *g* Internal cuneiform. *h* Middle cuneiform. *i* External cuneiform bone. *j* Cuboid bone. *k* Groove for tendon of peroneus-longus. *l l* Metatarsal bones. *m n o* First, second, and third phalanges of the toes. *p* Last phalanx of the great toe.

ular faces—one anterior and small, the other posterior and large, separated by a deep fossa for the interosseous ligament, and both faces articulating with the os calcis. The front of the astragalus is smooth and rounded for articulating with the naviculare. The posterior is grooved for the tendon of the flexor pollicis. Its outer surface is smooth for articulating with the malleolus externus. Its inner surface articulates with the malleolus internus.

The *os calcis—calx*, the heel, (Fig. 243,) is readily distinguished by being the largest bone of the tarsus, and being situated at its posterior and lower part. Its form is oblong. Its upper surface has two faces, separated by a groove, for articulating with the astragalus. Its lower surface is rather concave, and bounded posteriorly by two tubercles which give attachment to the aponeurosis plantaris and muscles of the foot. Its anterior extremity articulates with the cuboides by a slightly concave surface. Its posterior extremity is convex and rough, forms the heel, has a bursa, and receives the insertion of the *tendo Achillis*. Externally the calcis is rather flat and grooved for the passage of the peroneal tendons ; and internally it is hollowed and arched for the passage of the flexor tendons, tibialis posticus, and plantar vessels and nerves. It *articulates* with the astragalus and cuboid.

The *os naviculare* or *scaphoides* (Fig. 243) occupies a middle position at the upper and inner portion of the tarsus. Its form is oval. Its posterior surface is concave and smooth for articulating with the head of the astragalus. Its anterior surface is divided into three articular facets for the three cuneiform bones. Its inferior surface gives insertion to the tibialis posticus, and its external articulates with the cuboid.

This bone articulates with five,—the astragalus, cuboid, and three cuneiform bones.

The *os cuboides* (Fig. 243) is situated on the outside of the naviculare, and occupies the external and anterior portion of the tarsus. Its form is somewhat cubical. Its upper surface is rough and flat; its lower, irregular, rough, and grooved for the tendon of the peroneus-longus. Its

anterior surface has two smooth divisions for articulating with the fourth and fifth metatarsal bones; its posterior is smooth and concave to articulate with the os calcis.

It *articulates* with the os calcis, naviculare, external cuneiform, and two external metatarsal bones.

The *cuneiform bones* (Fig. 243) are situated on the anterior portion of the tarsus, and are wedge-shaped. The *internal* is the largest, and is articulated in front and to the outside to the middle cuneiform, and to the first and second metatarsal bones; behind it articulates with the naviculare, and below it gives attachment to the tendon of the tibialis posticus. The *middle cuneiform* is situated between the other two, is the smallest, and articulates also with the naviculare behind, and the second metatarsal in front. The *external cuneiform* is next to the cuboid, and articulates in front with the third metatarsal bone, behind with the naviculare, on the inside with the middle cuneiform, and on the outside with the cuboid.

The *tarsus* is *developed* by a single point for each bone, and ossification has been observed in the following order: in the sixth month in the calcis, seventh month in the astragalus, tenth month in the cuboid, first year in the external cuneiform, third year in the internal cuneiform, fourth year in the middle cuneiform and naviculare.

METATARSUS, (Fig. 243.)

The metatarsal bones are five in number.

The *first* corresponds to the great toe, and is the shortest and thickest. It is convex above and concave below. Its anterior extremity is round and smooth for articulating with the first phalanx of the great toe; its posterior extremity is concave, to articulate with the internal cuneiform bone. The *second metatarsal bone* is the longest, and articulates at its upper extremity with the three cuneiform bones; its lower extremity articulates with the first phalanx of the second toe. The *third metatarsal bone* is shorter than the second, and articulates at its tarsal extremity with the third cuneiform, and by its sides at this extremity

with the adjoining metatarsal bones. The *fourth metatarsal* is shorter than the third, and articulates with the cuboid, and by the inner side of its base with the third cuneiform bone. The *fifth metatarsal* is the shortest except the first, and articulates above with the cuboid, and presents on the outside of this joint a projecting tubercle. All the metatarsal bones have a similar *structure*, consisting of the compact and cellular.

The *phalanges* (Fig. 243) are three to each toe, except the great toe, which has but two—consequently there are fourteen in all. These, like the fingers, have each a body or shaft and two extremities.

The *first phalanges* are the longest; their upper extremity is concave for articulating with the head of the metatarsal bones. The base of the first phalanx of the great toe generally has two sesamoid bones.

The *second phalanges*—the great toe having none—are very short, and their upper extremities are concave for articulating with the convex end of the first phalanx.

The *third phalanges*, except that of the great toe, are small. They articulate by their upper extremity with the second phalanx, and have their upper surfaces broad and rough for the reception of the nails.

SECTION IV.

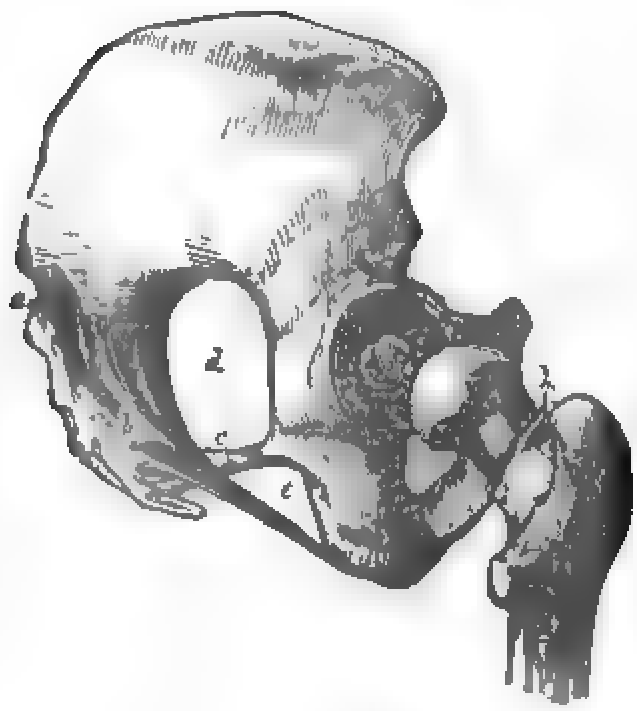
LIGAMENTS OF THE INFERIOR EXTREMITY.

Ligaments of the hip joint.—The bones of this joint comprise the head of the femur and the acetabulum, both of which are covered with cartilage and secured by the following ligaments:

The *capsular ligament* is one of the strongest and most perfect of the kind in the body. It is connected above to the outer circumference of the acetabulum, and below to the roots of both trochanters; thus enclosing the whole neck of the femur. It is longer behind and below than at any other point, but thicker and stronger above and in front from the presence of an accessory ligament, termed *ilio-femoral*. This extends, as a strong fibrous band, from the inferior

spinous process of the ilium, incorporates itself with the anterior capsular ligament, and goes to be attached to the front of the femur, near the trochanter minor.

FIG. 244.



The *cotyloid ligament* (Fig. 244) consists of fibro-cartilage, placed round the margin of the acetabulum to deepen its cavity. Its fibres are circular and strong, and thicker above than behind. Its free edge is sharp, and within the capsular ligament it is connected with some ligamentous fibres which stretch across the notch of the acetabulum, called the *transverse ligament.*

Ligamentum teres, round, or *interarticular ligament,* (Fig. 244.)—This is a round or triangular cord, about an inch and a half long, within the capsular. It is seen, by opening the latter, to be attached at one extremity to the depression in the head of the femur, and by the other which bifurcates, to the depression and borders of the notch of the acetabulum.

The *synovial membrane* forms a complete sac, which lines the acetabulum, covers the cotyloid and round ligament, and the head and neck of the femur; it also adheres to the reddish fatty mass filling the rough surface of the acetabulum.

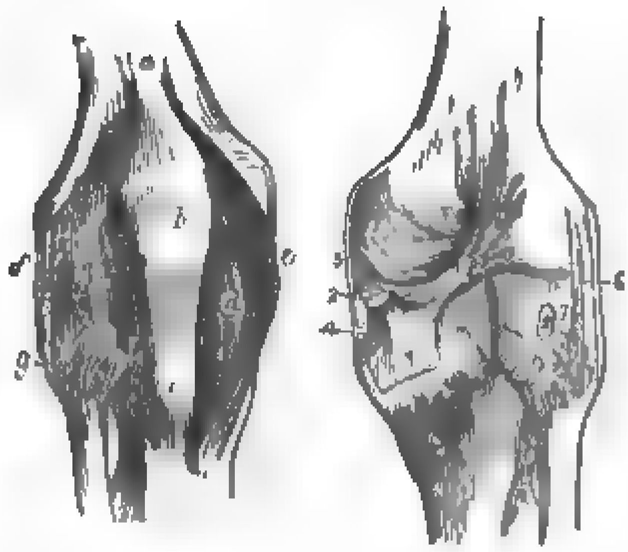
LIGAMENTS OF THE KNEE-JOINT.

The bones comprising this joint are the condyles of the femur, the patella, and head of the tibia. This is a very complicated joint, including a variety of ligaments.

FIG. 244 represents the ligaments of the Hip Joint. *a* Posterior sacro iliac ligament. *b* Greater sacro sciatic ligament. *c* Lesser sacro sciatic ligament. *d* Greater sacro sciatic notch. *e* Lesser sacro sciatic notch. *f* Cotyloid ligament. *g* Ligamentum teres. *h* Point of attachment of capsular ligament. *i* Obturator ligament.

The *ligamentum patellæ* (Fig. 245) is attached above to the inferior end of the patella, and below to the tubercle of the tibia. It consists of strong, thick, broad and parallel fibres, and is regarded as a continuation of the tendon of the recti muscles.

A Fig. 245. B



The *ligament of Winslow*, or *posterior ligament*, is situated on the posterior part of the joint, and forms a broad membranous expansion from the tendon of the semi-membranosus muscle, reaching from the inner side of the head of the tibia to the external condyle of the femur.

The *internal lateral ligament* (Fig. 245) consists of a flattened fasciculus of fibres which extend from the internal condyle of the femur to the inner side of the head of the tibia and semilunar cartilage.

The *external lateral ligament* (Fig. 245) extends frequently as a double cord from the outer side of the external condyle to the head of the fibula.

The *anterior crucial ligament* extends from the inner side and posterior part of the external condyle, obliquely forward and inward to the depression in front of the spine of the tibia.

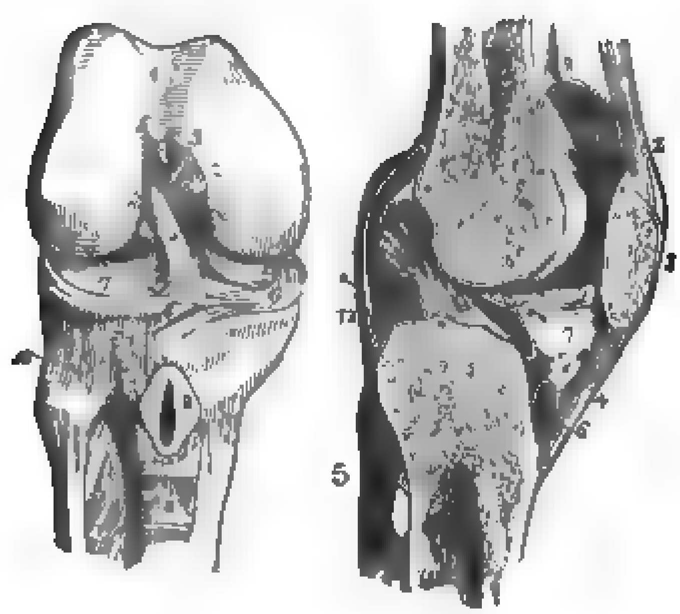
The *posterior crucial ligament* (Fig. 246) extends from the outer side and front of the inner condyle to the depression on the back of the spine of the tibia. These crucial ligaments

Fig. 245, A represents the ligaments upon the front and sides of the Knee Joint. *a* Tendon of the quadriceps femoris muscle. *b* Patella. *c* Ligament of patella. *d d* Synovial membrane. *e* Internal lateral ligament. *f* External lateral ligament. *g* Ligament connecting the fibula with the tibia.

Fig. 245, B represents the ligaments on the back part of the Knee Joint. 1 Ligament of Winslow. 2 Tendon of semi-membranosus muscle. 3 Its insertion. 4 The portion of it which goes under the internal lateral ligament. 5 Internal lateral ligament. 6 External lateral ligament. 7 Fibres of external lateral ligament. 8 Section of tendon of popliteus muscle. 9 Superior posterior peroneo-tibial ligament.

are very strong, and are relaxed when the leg is bent, but tense when it is extended.

A Fig. 246. B



The *semilunar cartilages* (Fig. 246) are situated upon the superior articular surface of the tibia, and are two in number, an *external* and an *internal*. The outer edge of each is thick, the inner edge thin, sharp, and loose. The upper surface of each is concave, the lower surface flat. The *external* receives the head of the outer condyle, and is more circular and movable than the *internal*, which receives the inner condyle. The circumference of the semilunar cartilages is attached to the margin before and behind the spine of the tibia, and to the lateral ligaments. These cartilages are connected in front by fibres called the *transverse ligament*.

The *synovial membrane* is both extensive and complex. It covers the head of the tibia, both surfaces of the semilunar cartilages, the condyles of the femur, the inner surface of the patella, the crucial ligaments, and posterior surface of the tendons of the recti muscles. It gives off several reflections which have been styled ligaments. The double fold of this membrane upon a quantity of fat behind

Fig. 246, A represents the Knee Joint laid open. 1 Lower end of femur. 2 Anterior crucial ligament. 3 Posterior crucial ligament. 4 Fasciculus attached to semilunar cartilages. 5 Point where ligamentum mucosum is attached. 6 Internal semilunar cartilage. 7 External semilunar cartilage. 8 Ligamentum patellæ. 9 Bursa laid open. 10 Superior peroneo-tibial articulation. 11 Interosseous ligament.

Fig. 246, B represents a vertical section of Knee Joint. 1 Cellular structure of lower end of femur. 2 Common tendon of the extensor muscles, attached to the patella. 3 Patella. 4 Ligamentum patellæ. 5 Cancellated structure of tibia. 6 Bursa between tibia and ligament of patella. 7 Adipose matter projecting into the joint. 8 Synovial membrane. 9 One of the ligamenta alaria. 10 Ligamentum mucosum. 11 Anterior crucial ligament. 12 Posterior crucial ligament.

the patella, receives the name of *external* and *internal alar ligaments*, and another fold passing from this fatty matter behind the patella upward and backward to the hollow between the condyles, is called *ligamentum mucosum*. (Fig. 246.)

The tibia and fibula are connected at their extremities by the *superior* and *inferior tibio-fibular* articulations, and their shafts by an interosseous membrane.

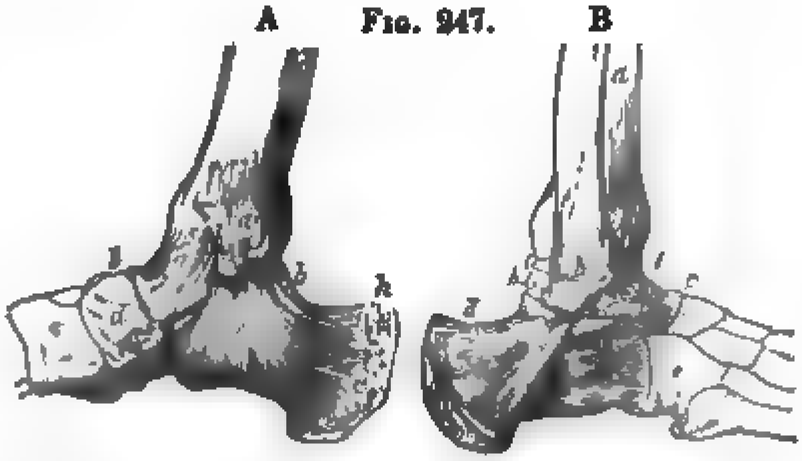
The superior articulation is formed of an *anterior* and a *posterior* ligament, which pass from the head of the tibia to the head of the fibula. There is also a distinct synovial membrane. The *inferior articulation* has also an *anterior* and a *posterior* ligament, which pass from the lower extremity of the fibula to contiguous portions of the tibia.

A synovial membrane is seen communicating with the ankle joint.

The *interosseous ligament* fills the space between the two bones, and passes from the external edge of the tibia to the corresponding edge of the fibula.

LIGAMENTS OF THE ANKLE JOINT.

A Fig. 247. B



The bones composing this joint are the astragalus below, and the tibia and fibula above.

The *anterior ligament*, not always distinct, extends from the anterior margin of the tibia to the upper part of the astragalus.

Fig. 247, A represents Ligaments at the inner side of the Ankle Joint. *a* Internal malleolus. *b b* Part of astragalus. *c* Os calcis. *d* Scaphoides. *e* Internal cuneiform bone. *f* Deltoid or internal lateral ligament. *g* Synovial capsule. *h* Tendo-Achillis.

Fig. 247, B represents Ligaments on the outer side of Ankle Joint. *a* Tibia. *b* External malleolus. *c c* Astragalus. *d* Os calcis. *e* Cuboides. *f g h* External lateral ligament arranged into three fasciculi, anterior, middle, and posterior. *i* Capsular ligament.

The *deltoid* or *internal lateral* ligament (Fig. 247) extends from the inferior margin of the malleolus internus in a radiated manner to the os calcis, naviculare, and astragalus.

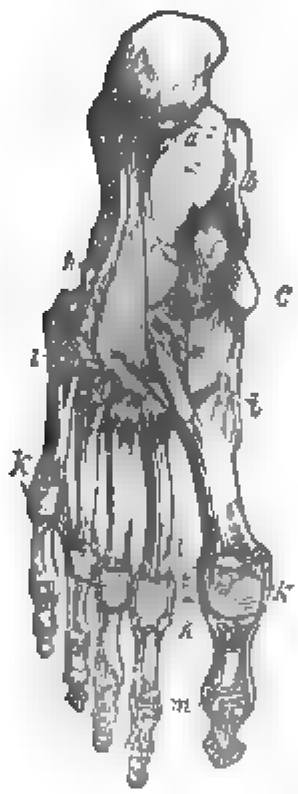
The *external lateral ligament* is composed of three distinct fasciculi, an anterior, posterior, and middle, all of which extend from the external malleolus to the astragalus and os calcis. There is the usual synovial membrane.

LIGAMENTS OF THE FOOT.

These comprise the *tarsus*, *metatarsus*, and *phalanges*.

The *ligaments* of the *tarsus* are divided into the *dorsal* and *plantar*. An *interosseous ligament* connects the astragalus and os calcis, and is situated in the fossa between their articular surfaces, and a *posterior* ligament also unites them behind.

FIG. 248.



The *calcaneo-scaphoid* (Fig. 248) is double, consisting of an *internal* and *external* portion; both of these are on the plantar surface. The *internal* consists of a broad fibro-cartilaginous band, which extends from the lesser tubercle of the os calcis to the lower and inner surface of the naviculare. It forms a trochlea for the play of the tendons of the flexor longus pollicis and flexor digitorum. The *external* portion extends from the greater tubercle of the calcis to the external under surface of the naviculare.

The *calcaneo-cuboid* (Fig. 248) is also double. The *plantar* portion is large, and extends from the under surface of the calcaneum to the cuboides, and even as far as the third

FIG. 248 represents the Ligaments on the sole of the Foot. *a* Inferior surface of the calcis. *b* Astragalus. *c* Scaphoides. *d e* Calcaneo-cuboid ligament. *f* Calcaneo-scaphoid ligament. *g* Plantar ligaments. *h h* Tendon of Peroneus longus. *i i* Tarso-metatarsal plantar ligaments. *j* Capsular ligament of first joint of the great toe. *k* Lateral ligaments of the first joints of the toes

and fourth metatarsal bones. The *dorsal* portion consists of thin broad layers of fibres, which extend from the anterior upper surface of the os calcis to the upper surface of the cuboides.

The navicular bone and cuboid are united by an interosseous ligament, and the naviculare and three cuneiforme bones are connected by a triple ligament passing from one to the other. A synovial membrane belongs to all the articular surfaces.

The *ligaments of the metatarsus* consist chiefly of transverse dorsal and plantar fibres, which pass from the tarsal to the metatarsal bones on the top and sole of the foot, and interosseous ligaments situated at the sides of the tarsal ends of the four metatarsal bones of the small toes.

The *ligaments of the phalanges* have a very similar arrangement with those of the fingers, and it may therefore simply be remarked that the anterior ends of each metatarsal bone are connected by transverse fibres, called *anterior plantar ligaments.* They are received into the cavities of the first phalanges, being furnished, as all the phalanges, with lateral ligaments and synovial membranes.

CHAPTER II.

ACTIVE ORGANS OF THE INFERIOR EXTREMITY.

SECTION I.

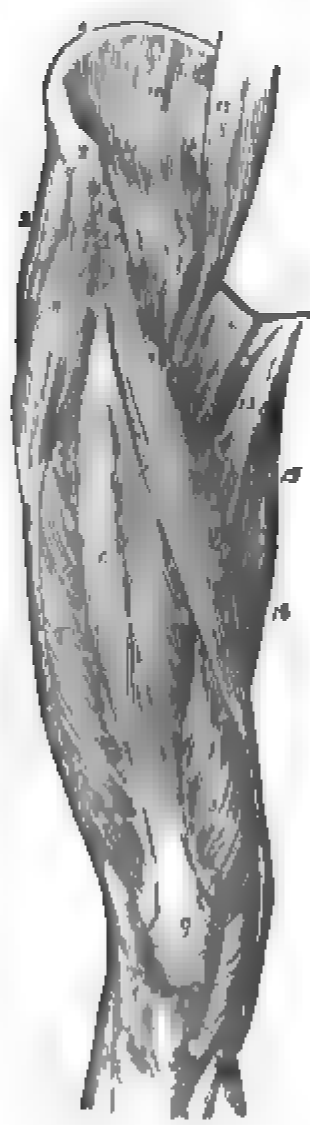
MUSCLES OF THE INFERIOR EXTREMITY.

Muscles of the Thigh.—Those on the *anterior* and *internal thigh.* The psoas and iliacus internus muscles are described under another head.

Dissection.—Make an incision from the anterior superior spinous process of the ilium, along Poupart's ligament to the spine of the pubis. From the centre of this make a second down the front and middle of the thigh, to a little below the knee; cross this latter by two transverse incisions, one at the upper, the other at the lower third of the

thigh. Turn aside first the integument, then the superficial fascia, bringing in view the fascia lata, which should be carefully examined. The fascia lata being turned off, the muscles are exposed.

FIG. 249.



The *tensor vaginæ femoris* (Fig. 249) *arises* from the outer portion of the anterior superior spinous process, tendinous; becomes fleshy as it descends, and is *inserted* thin and broad between the two layers of the fascia lata, below the trochanter major, on the outer side of the thigh.

Function.—To stretch the fascia and turn the foot inward.

The *sartorius*—tailor's muscle—(Fig. 249) *arises* from the anterior superior spinous process of the ilium by a short tendon, and from the notch below. Becoming fleshy it forms a flat riband-like muscle, which takes a spiral course to the inner side of the thigh; thence to the back of the inner condyle, forward by the head of the tibia, to be *inserted* into the inner side of its tubercle by a broad tendon which is continued into the fascia of the leg. In its course it crosses the rectus, vastus internus, and triceps adductor, and is the longest muscle in the body.

Function.—To bend the leg and turn it obliquely inward. The action of both muscles is to cross the legs after the manner of tailors, which has given the name to the muscle.

The *rectus femoris* (Fig. 249) *arises* by two tendons—one round, from the anterior inferior spinous process of the ilium, the other broad, from the superior and outer border

FIG. 249 represents the Muscles on the anterior part of the Thigh. 1 Crest of the ilium. 2 Anterior superior spinous process. 3 Gluteus medius. 4 Tensor vaginæ femoris. 5 Sartorius. 6 Rectus femoris. 7 Vastus externus. 8 Vastus internus. 9 Patella. 10 Iliacus internus. 11 Psoas magnus. 12 Pectineus. 13 Adductor longus. 14 Adductor magnus. 15 Gracilis.

of the acetabulum. It forms a complete penniform muscle, which, running in front of the thigh, is *inserted*, by a strong, flat tendon, into the superior margin of the patella.

Function.—To extend the leg.

The *vastus externus* (Fig. 249) *arises*, tendinous and fleshy, from the root of the great trochanter, and from the whole length of the linea aspera at its outer edge, from the ridge leading to the external condyle, and from the outer surface of the femoral bone. Its fibres descend obliquely, and are *inserted* into the outer edge of the tendon of the rectus, and outer edge of the patella. This is a large muscle upon the outer thigh. *Function.*—To extend the leg, also to turn the knee outward.

The *vastus internus* (Fig. 249) *arises* from the front of the femur, at the trochanter minor, and covers all the inner side of this bone; arises also from the whole inner edge of the linea aspera, and from the ridge going to the inner condyle. Its fibres descend obliquely, and are *inserted* into the inner edge of the tendon of the rectus, and inner edge of the patella. It is smaller and shorter than the vastus externus. *Function.*—To extend the leg.

The *cruræus* arises fleshy from all the front of the femoral bone and its outside, to the linea aspera. It is unconnected with the bone, on its inner side, for about the breadth of an inch, and extending thus nearly the whole length of the shaft. It is behind the rectus, and overlapped by the two vasti. Its *insertion* is into the upper edge of the patella, behind the tendon of the rectus.

Function.—To extend the leg. The last three muscles receive the name of *triceps extensor femoris*, and, including the *rectus*, are called *quadriceps femoris*. A few muscular fibres of the cruræus are seen going to the synovial membrane of the joint, and take the name of *sub-cruræus*. A large bursa is found behind the cruræus, just above the patella, and sometimes on the patella.

The *gracilis* (Fig. 249) arises from the inner edge of the descending ramus of the pubis and lower half of the symphysis, by a broad, thin tendon, which descends fleshy and

riband-like from the pelvis to the leg, and being the inner muscle of the thigh, forms at its lower part a round tendon, which goes behind the internal condyle and head of the tibia, and then curves forward beneath the tendon of the sartorius to be inserted at the lower and lateral part of the tubercle of the tibia. *Function.*—To flex the leg; also to adduct it.

The *pectineus* or *pectinalis* (Fig. 249) arises fleshy from the upper concave surface of the pubis, forms a short, flat, triangular muscle, situated at the inner and upper part of the thigh, and is *inserted* tendinous into the linea aspera, just below the trochanter minor. *Function.*—To turn the thigh inward and forward.

The *triceps adductor femoris* (Fig. 249) consists of three portions, viz:

The *adductor longus*—which arises from the anterior upper surface of the pubes between its spine and symphysis by a short round tendon—forms a flat, triangular muscle, situated between the gracilis and pectinalis, and is *inserted* broad into the middle third of the linea aspera. *Function.*—To bring the thigh inward and forward.

The *adductor brevis* arises tendinous from the anterior lower surface of the pubes, is beneath the adductor longus and pectinalis, and goes to be inserted into the superior third of the linea aspera. *Function.*—The same as the last.

The *adductor magnus* arises fleshy from the descending ramus of the pubis, and ramus of the ischium as far as its tuberosity, covering the surface between the thyroid foramen and margin of the bone. It is much the largest and longest of the adductors, and is inserted fleshy and tendinous into the whole of the linea aspera, and by a round tendon continued into the internal condyle of the femur. *Function.*—The same as the last.

MUSCLES ON THE POSTERIOR THIGH.

Dissection.—Make a longitudinal incision along the middle of the back of the thigh, and a transverse one at the centre.

The *glutei* are described along with the rotators of the thigh, under the head of muscles of the pelvis, which see.

The *biceps flexor cruris* arises by two heads; the long head by a short tendon, in common with the semi-tendinosus, from the back part of the tuberosity of the ischium; the short head comes from the lower third of the linea aspera and joins the long. A strong tendon is thus formed, constituting the outer hamstring, which goes to be inserted into the head of the fibula. A bursa is seen between this tendon and the external lateral ligament. *Function.*—To bend the leg.

FIG. 250.

The *semi-tendinosus* (Fig. 250) arises from the tuberosity of the ischium in common with the long head of the biceps, to which it adheres for three or four inches, becomes large and fleshy, and ends in a round, long tendon, constituting one of the inner hamstring muscles, which goes behind the internal condyle to be *inserted* into the side of the tibia below its tubercle. *Function.*—To bend the leg.

The *semi-membranosus* (Fig. 250) arises from the tuberosity of the ischium, at its upper and outer part tendinous, soon forms a membranous expansion, and becoming fleshy, ends below in a tendon constituting the other inner hamstring, which passes behind the internal condyle, to be inserted into the back and inner part of the head of the tibia, just below its joint. At this point the tendon sends off a broad aponeurosis, covering the back of the joint, and passing beneath

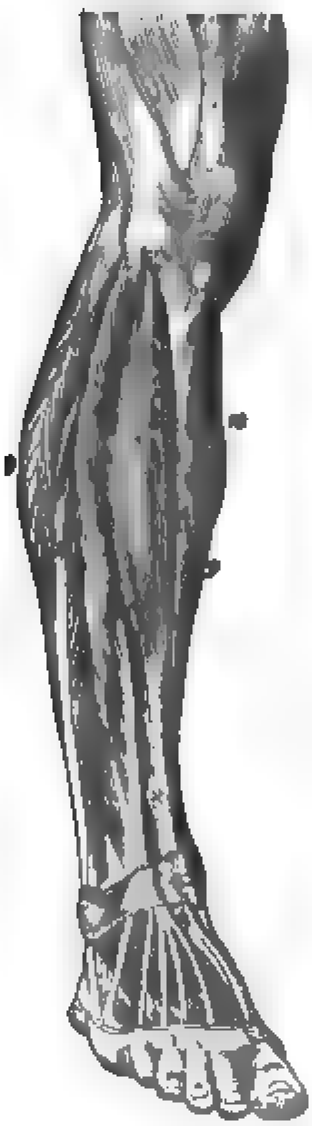
FIG. 250 represents the Muscles on the Posterior Thigh. *a* Gluteus medius. *b* Gluteus maximus. *c* Fascia lata. *d* Long head of the biceps flexor cruris. *e* Short head of the same muscle. *f* Semitendinosus. *g g* Semi-membranosus. *h* Gracilis. *i* Adductor magnus. *j* Sartorius. *k* Popliteal space. *l* Gastrocnemius.

the heads of the gastrocnemii to the external condyle, which has been called the posterior ligament, or ligament of Winslow.

MUSCLES OF THE LEG.

Those on the anterior and outer leg. *Dissection.*—Make an incision from the knee joint along the middle of the leg between the tibia and fibula, over the ankle joint along the dorsum of the foot to the toes. Make a second incision crossing the first transversely over the ankle joint. Turn aside the integument, and then the fascia, when the muscles will be exposed.

Fig. 251.



The *tibialis anticus* (Fig. 251) arises fleshy from the head of the tibia, the outer edge of its anterior spine for about two-thirds of its length, the interosseous ligament and fascia of the leg. A large fleshy muscle is formed, which ends in a strong tendon that passes through a distinct ring of the annular ligament, in front of the malleolus internus, goes to be *inserted* into the base of the internal cuneiform bone at the inner side of the foot, and also into the adjoining base of the metatarsal bone of the great toe. A bursa is seen beneath the tendon, where it goes through the annular ligament. *Function.*—To flex the foot and turn it obliquely inward.

The *extensor communis digitorum pedis* (Fig. 251) *arises* fleshy and tendinous from the outer head of the tibia, from

Fig. 251 represents the Muscles on the front of the Leg. 1 Quadriceps femoris tendon. 2 Spine of the tibia. 3 Tibialis anticus. 4 Extensor communis digitorum. 5 Extensor proprius pollicis. 6 Peroneus tertius. 7 Peroneus longus. 8 Peroneus brevis. 9 9 Edges of the soleus. 10 Gastrocnemius. 11 Extensor brevis digitorum.

the head of the fibula and upper three-fourths of this bone; also from the interosseous ligament, intermuscular septa, and fascia of the leg. Its fibres descend obliquely inward, and about the middle of the leg it divides into four tendons, which pass through a common ring under the annular ligament, and then diverge, expanding over the back of all the toes, except the great toe, to be attached to the last phalanx of each. A bursa is connected with these tendons at the annular ligament. *Function.*—To extend the toes and flex the foot.

The *extensor proprius pollicis* (Fig. 251) *arises* tendinous and fleshy from the middle third of the fibula, and from the interosseous ligament nearly as low as the ankle. Its fibres descend obliquely forward to a tendon which passes under the annular ligament to be *inserted* into the base of the first and second phalanx of the great toe. A bursa is seen with the tendon at the annular ligament. *Function.*—To extend the great toe.

The *peroneus longus* (Fig. 251) *arises* around the head of the fibula, tendinous and fleshy, from the two upper thirds of the external angle of the fibula, and from the fascia and intermuscular septa. Its fibres pass obliquely outward to a flat tendon, which goes behind the external malleolus through a ligamentous noose provided with a bursa, and thence proceeds to the outer side of the os calcis, and through a groove in the cuboides where it meets with another bursa, and is now traced deep in the sole of the foot next to the tarsal bones, inward and forward, to be *inserted* into the internal cuneiform and base of the metatarsal bone of the great toe. *Function.*—To extend the foot and turn it obliquely outward.

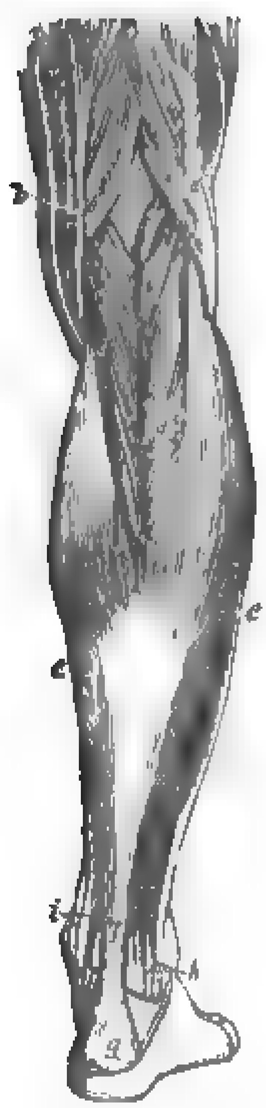
The *peroneus brevis* (Fig. 251) *arises* fleshy and tendinous from the outer surface of the lower two-thirds of the fibula. It ends in a tendon which passes behind the external malleolus in the same groove with, and concealed by the peroneus longus, and goes to be *inserted* into the os cuboides and base of the metatarsal bone of the little toe. *Function.*—The same as the last.

The *peroneus tertius* (Fig. 251) forms a portion of the extensor longus, and goes to the base of the metatarsal bone of the little toe. *Function.*—To flex the foot.

MUSCLES ON THE BACK OF THE LEG.

Dissection.—Make an incision down the middle back part of the leg from the knee to the heel, cross this at its centre by a transverse incision, then turn off the integument and fascia, when the muscles will be exposed.

[Fig. 252.



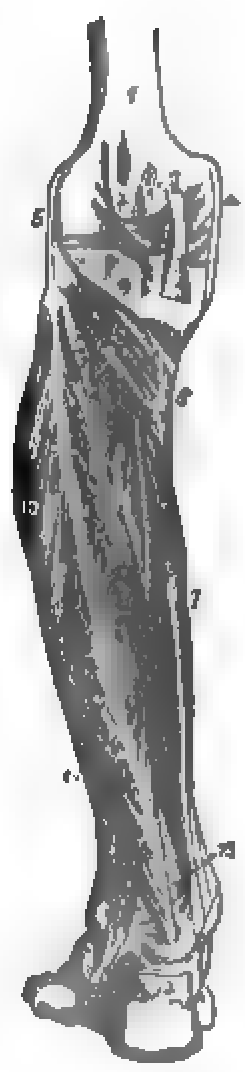
Gastrocnemius—γαστηρ, the belly; κνημη, the leg—(Fig. 252) *arises* by two heads; one tendinous and fleshy, from the external condyle and ridge leading to it; the other head has a like origin from the internal condyle and its ridge. The two heads have the popliteal vessels passing between them. They unite a little below the knee and about the middle of the leg form a broad flat tendon to unite with the *soleus* or *gastrocnemius internus*, which arises fleshy from the head and upper third of the fibula, from the upper posterior surface of the tibia, below the popliteus, and from the internal angle of the tibia for four or five inches. A large fleshy belly is formed, constituting the calf of the leg, which ends in a tendon to unite with that of the gastrocnemius externus. The union of the two forms the *tendo-Achillis*, which goes to be *inserted* into the posterior part of the os calcis. A bursa is found between this tendon and the bone. *Function.*—To extend the foot.

Fig. 252 represents the Superficial Muscles on the back of the Leg. *a* Tendon of the biceps. *b* Tendons of the inner hamstring muscles. *c* Popliteal space. *d* Gastrocnemius. *e* Soleus. *f* Tendo-Achillis. *g* Its insertion into the calcis. *h* Peroneus longus and brevis tendons. *i* Tendons of the flexor-longus-digitorum, and tibialis posticus.

The *plantaris* arises fleshy from the ridge leading to the external condyle, forms a short fleshy belly hid by the gastrocnemius, which passes across and adheres to the capsular ligament of the joint. It ends in a long, flat, delicate tendon which emerges between the gastrocnemius and soleus, and then descends along the inner edge of the tendo-Achillis to be *inserted* into the posterior and inner part of the os calcis. *Function.*—To extend the foot. This muscle is sometimes absent.

The *popliteus* arises by a round tendon on the outer face of the external condyle, behind the knee-joint, and forms a fleshy belly, which descends inward to be *inserted* into the ridge below the head of the tibia. A bursa is seen between its tendon and the capsular ligament. *Function.*—To flex the leg and turn it inward.

Fig. 253.



The *flexor longus* or *communis digitorum pedis* (Fig. 253) *arises* from the posterior part of the tibia, below the popliteus, and from the angle of the tibia, nearly to the ankle joint. It ends in a tendon which runs in a groove behind the internal malleolus, being confined here by a strong ligamentous band; it then passes along the sinuosity of the os calcis to the sole of the foot, receiving at this point an accessory tendon from the flexor longus pollicis. It divides into four tendons which pass through slits in the flexor brevis, and are *inserted* into the base of the third phalanx of the smaller toes. This mus-

Fig. 253 represents the deep Muscles on the back of the Leg. 1 Lower portion of the femur. 2 Ligament of Winslow. 3 Tendon of semi-membranosus. 4 Internal lateral ligament of the knee-joint. 5 External lateral ligament of the same joint. 6 Popliteus muscle. 7 Flexor longus digitorum pedis. 8 Tibialis posticus. 9 Flexor longus pollicis. 10 Peroneus longus. 11 Peroneus brevis. 12 Insertion of tendo-Achillis. 13 Tendons of flexor longus and tibialis posticus.

cle is consequently a perforans. A bursa is found with this tendon at the os calcis and sole of the foot.

Function.—To bend the smaller toes and extend the foot.

The *flexor longus pollicis* (Fig. 253) *arises* tendinous and fleshy from the posterior surface of the lower two-thirds of the fibula. It ends in a tendon which goes through a groove in the back part of the tibia and astragalus, connects with the flexor longus digitorum, and goes to be *inserted* into the last phalanx of the great toe.

Function.—To bend the great toe and extend the foot.

A bursa is seen in connection with the tendon at the astragalus, os calcis, metatarsal bone and phalanx.

The *tibialis posticus* (Fig. 253) *arises* from the front of the tibia where it connects with the fibula, and gets through the interosseous ligament, arising from this latter almost its whole length, as well as from the fibula and tibia adjacent to the ligament. It ends in a tendon which passes behind the internal malleolus forward and inward, to be *inserted* into the naviculare, internal cuneiform, cuboid, and second and third metatarsal bones. At its insertion a small sesamoid bone and bursa are seen. *Function.*—To extend the foot and turn it obliquely inward.

MUSCLES OF THE FOOT.

Dissection.—Make an incision from the heel, along the inner and outer margins of the foot; turn down the integument, and then the thick adipose layer to the plantar aponeurosis. The latter being removed, the muscles are exposed.

The muscles on the sole of the foot are divided into four layers.

FIRST LAYER.

The *abductor pollicis pedis* arises, tendinous and fleshy, from the internal and lower part of the os calcis, and from the annular ligament, and plantar aponeurosis. Its fibres run along the inner side of the foot, and are *inserted* into the base of the first phalanx of the great toe and the inner sesamoid bone. *Function.*—To draw the great toe from the others.

The *abductor minimi digiti pedis* (Fig. 254) *arises* tendinous and fleshy from the outer side of the os calcis, the plantar fascia, and the base of the metatarsal bone of the little toe, and is *inserted* tendinous into the outer part of the base of the first phalanx of the little toe, running along the outer margin of the foot.

Fig. 254.

Function.—To draw the little toe from the rest.

The *flexor brevis digitorum pedis* (Fig. 254) *arises* fleshy from the lower surface of the os-calcis, from the plantar aponeurosis, and the intermuscular septa. It forms a fleshy mass, situated between the two former muscles, and about the middle of the metatarsal bones it divides into four tendons, each of which has a slit for the passage of the flexor longus, and is inserted into the base of one of the second phalanges of the smaller toes. This muscle is hence a perforatus.

Function.—To flex the second joint of the toes.

SECOND LAYER.

The *flexor accessorius*, or *massa carnea Jacobi Sylvii*, (Fig. 255,) *arises* fleshy and tendinous from the lower and inner part of the os calcis, and is *inserted* into the outer side of the tendon of the flexor longus just as it is dividing into its four tendons. *Function.*—To flex the toes.

The *lumbricales pedis* (Fig. 255) *arise* by four tendinous and fleshy slips (consist in fact of four small muscles) from the tendon of the flexor longus digitorum, and are *inserted*

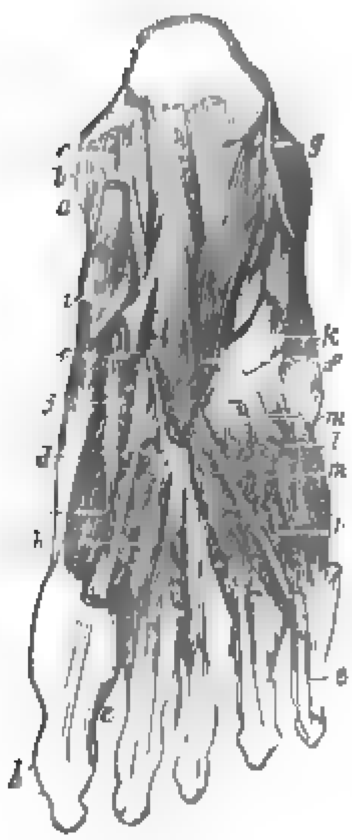
Fig. 254 represents the first layer of Muscles on the sole of the Foot. *a* Abductor pollicis pedis. *b b* Its tendon. *c c* Flexor brevis pollicis pedis. *d* Tendon of flexor longus pollicis. *e* Aponeurosis plantaris. *f* Flexor brevis digitorum pedis. *g* Lumbricales. *h* Abductor minimi digiti pedis. *i* Flexor brevis minimi digiti. *j* Interossei.

into the base of the smaller toes at the first phalanx and expansion of the extensor tendons.

THIRD LAYER.

The *flexor brevis pollicis* (Fig. 255) *arises* by two heads, between which the tendon of the long flexor passes, from the lower surface of the os calcis and external cuneiform bone. It forms a fleshy belly, connected with the abductor and adductor pollicis, and is *inserted* into the two sesamoid bones at the first phalanx of the great toe.

FIG. 255.



Function.—To flex the first joint of the great toe.

The *adductor pollicis* (Fig. 255) *arises*, tendinous and fleshy, on the outside of the last, from the calcaneo-cuboid ligament, and base of the second and third metatarsal bones, and is *inserted* into the external sesamoid and base of the first phalanx of the great toe. *Function.*—To bring the great toe towards the rest.

The *transversalis pedis arises* from the heads of the four lesser metatarsal bones by fleshy slips, which running transversely are *inserted* into the base of the first phalanx of the great toe. *Function.*—To approximate the toes.

The *flexor brevis minimi digiti* (Fig. 255) arises tendinous and fleshy from the cuboid and base of the fifth metatarsal bone, and is inserted into the base of the first phalanx of the little toe. *Function.*—To flex the little toe.

FIG. 255 represents the second, third and fourth layers of muscles on the sole of the foot. *a* Tendon of tibialis posticus. *b* Tendon of flexor longus pollicis. *c* Tendon of flexor longus digitorum. *d* Division of the latter into four tendons. *e* Their points of insertion. *f* Flexor accessorius. *g* Calcaneo cuboid ligament. *h* Lumbricales pedis. *i* Abductor pollicis. *j* Flexor brevis pollicis. *k* Tendon of peroneus longus. *l* Flexor brevis minimi digiti. *m* Interossei.

FOURTH LAYER.

The *interossei plantares* (Fig. 255) are three in number, and occupy the interosseal spaces. They arise from the base of the metatarsal bones, corresponding to the three outer toes, and are inserted into the base of the first phalanx of these toes at their inner side. *Function.*—To adduct the toes.

MUSCLES ON THE DORSUM OF THE FOOT.

The *extensor brevis digitorum pedis* (Fig. 256) arises tendinous and fleshy from the anterior and outer part of the os calcis, crosses the foot obliquely, and divides into four delicate tendons. The most internal is inserted into the base of the first phalanx of the great toe; the other three join the tendons of the extensor longus, which expand on the back of the other toes. *Function.*—To extend the toes.

FIG. 256.

The *interossei dorsales* (Fig. 256) are four in number, on the back of the foot, and resemble those on the hand in arising by two heads from adjacent sides of the metatarsal bones. The first is inserted on the inner side of the first phalanx of the second toe, and is an adductor. The other three are inserted on the outer side of the second, third, and fourth toes, and are *abductors.*

SECTION II.

FASCIÆ OF THE INFERIOR EXTREMITY.

The fasciæ of the thigh are divided into the *superficial fascia* and *fascia lata.*

FIG. 256 represents the muscles on the Dorsum of the Foot. *a b c* Extensor brevis digitorum pedis. *d* Occasional supernumerary tendon. *e* Section of tendons of Extensor communis. *f* Section of tendon of Extensor proprius pollicis. *g* Interossei muscles. *h* Superior astragalo scaphoid ligament.

The *superficial* is a continuation of the same loose membrane covering the abdomen. As it passes over Poupart's ligament, it becomes more closely connected with the deep layer. Upon the thigh it can be separated into two layers, enclosing the lymphatic glands of the groin, adipose matter, and superficial vessels and nerves. It can be traced inward to the symphysis pubis, and backward over the gluteal muscles. In the groin it has a close connection with the fascia-lata.

The *fascia lata* or *femoral aponeurosis* completely invests the thigh, not only surrounding all its muscles, but sending partitions within so as to form separate sheaths for each.

It *extends* from the pelvis above, where it is continuous with the iliac and perineal fascia, to the knee below, where it is traced into the fascia of the leg.

Above it is connected anteriorly and externally to Poupart's ligament and the crest of the ilium, internally to the rami of the pubis and ischium, and posteriorly to the sacrum and coccyx; below it surrounds the knee-joint, and is attached to the condyles. This fascia is very strong, but varies in strength and density at different points. On the gluteus maximus it is thin and weak; on the gluteus medius it is very thick and strong; on the outer side of the thigh it is much thicker and stronger than on the inner. It has been stated that the fascia lata surrounds and forms separate sheaths for the muscles by the various processes it sends off. It is connected to the linea-aspera, and by its processes affords attachment to several muscles. It presents many foramina on its surface, which give passage to vessels and nerves. One large opening is especially noticed in it, about two inches below Poupart's ligament, for the internal saphena vein.

This saphenic opening becomes the dividing point of the fascia lata into two portions. All on its outside being called the *iliac*, and all on its inside the *pubic* portion of the fascia lata. The iliac portion is attached to Poupart's ligament, and goes in front of the femoral vessels in the form of a crescent, and is hence called the *crescentic* or *falciform* pro-

cess. The *pubic portion* is connected to the spine and linea innominata of the pubis, goes behind the femoral vessels, and is continuous with the fascia iliaca. Between and connected to the margins of the falciform, pubic, and iliac portions of the fascia lata, a thin membrane, having many foramina for the passage of vessels, is seen, called *cribriform fascia.* The fascia lata is distinctly double at some points, as for instance where it receives the insertion of the tensor vaginæ femoris muscle between its two layers.

The *fascia of the leg* is continuous, as stated, with the fascia lata. It is strongly attached to the head of the tibia and fibula, to the spine of the tibia, to the external and internal malleolus, and at the ankle-joint thickens, to form the annular ligaments. It also surrounds, and at its upper portion sends processes between the muscles, called intermuscular septa. On the anterior leg it is thicker than behind, and in front of the ankle joint it forms the *anterior annular ligament,* which is about an inch and a half broad. It is attached to the os calcis on its outer side; whence it spreads forward, and to the inner side, where it presents two bands, one going to the internal malleolus, the other to the naviculare, and the plantar fascia. The extensor tendons pass beneath this ligament, having distinct sheaths with bursæ. Posteriorly the fascia is thinner and double. Its strength is however increased by fibres from the hamstring tendons. Its superficial layer is immediately beneath the skin. Its deep layer is situated between the tibia and fibula, and is called the *intermuscular fascia.* At the ankle joint the posterior fascia of the leg, its superficial portion, becomes thickened to form the *external* and *internal annular ligaments.* The former stretches from the outer malleolus to the os-calcis, and binds down the peroneal tendons; the latter goes from the internal malleolus, to the tuberosity and side of the calcis. This is a strong ligament and gives passage and protection to the flexor tendons and vessels.

The *fascia* upon the *dorsum of the foot* is continued from the anterior annular ligament, and forms only a thin layer.

The *plantar fascia* (*aponeurosis plantaris*) is a very thick,

dense, fibrous membrane, situated between the skin and muscles, attached to the tubercles of the os calcis, and spreading over the whole sole of the foot. It is divided into three portions,—an outer, attached to the base of the fifth metatarsal bone—an inner connected to the metatarsus of the great toe; and a middle, much thicker and denser, which, as it leaves the os calcis, expands, and, at the heads of the metatarsal bones, divides into five fasciculi, each of which again divides so as to form a slit for the passage of the flexor tendons. These go to be inserted into the sides of the basis of the first phalanges of the toes.

SECTION III.

BLOOD-VESSELS OF THE INFERIOR EXTREMITY.

The *femoral* and *popliteal* arteries, with their branches, are the sources of arterial supply to the lower extremity.

FEMORAL ARTERY.

The *femoral artery* is a continuation of the external iliac. At about the centre of Poupart's ligament it commences, and extends obliquely inward along the anterior thigh to an opening in the adductor magnus muscle, through which it passes, and changes its name to *popliteal.*

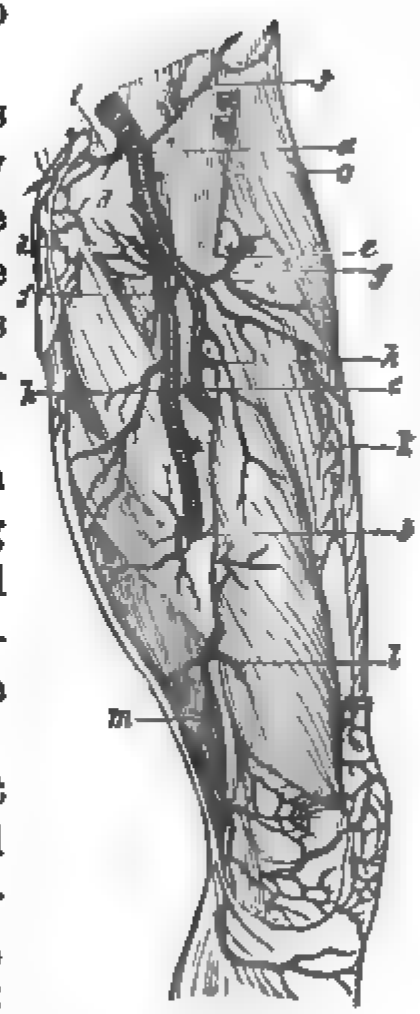
In its course it first passes over the common junction of the psoas magnus and iliacus internus, then over the adductors brevis and longus. Above it is rather superficial and simply covered by a thin layer of the fascia lata; at the middle of the thigh the sartorius crosses it, and here is also seen a strong covering of aponeurotic membrane from the vastus internus, and adductor longus. At Poupart's ligament the femoral vein is on the inside of the artery, while as it descends the vein gets behind it. The anterior crural nerve is to the outside, and one of the branches descends along the front of the artery within the sheath.

A line drawn from midway between the anterior superior spinous process of the ilium and symphysis pubis to the inner side of the patella, will indicate the course of this vessel.

BRANCHES OF THE FEMORAL ARTERY, (Fig. 257.)

The *superficial epigastric* comes from the femoral, just below Poupart's ligament, pierces the fascia-lata, and ascends to the umbilicus, immediately beneath the skin, giving branches to the inguinal glands.

FIG. 257.



The *superficial circumflexa ilii* comes also from the femoral, just below Poupart's ligament, goes through the fascia, and proceeds outward to the crest of the ilium, giving branches to the glands of the groin, the superficial fascia, and the skin.

The *external pudic*, two or three in number, small, and sometimes coming from a common trunk, are distributed upon the inguinal glands, penis, scrotum of the male, and labia of the female.

The *profunda femoris* is the largest branch, and comes from the femoral about two inches below Poupart's ligament. It descends behind the femoral, and gives off the following branches:

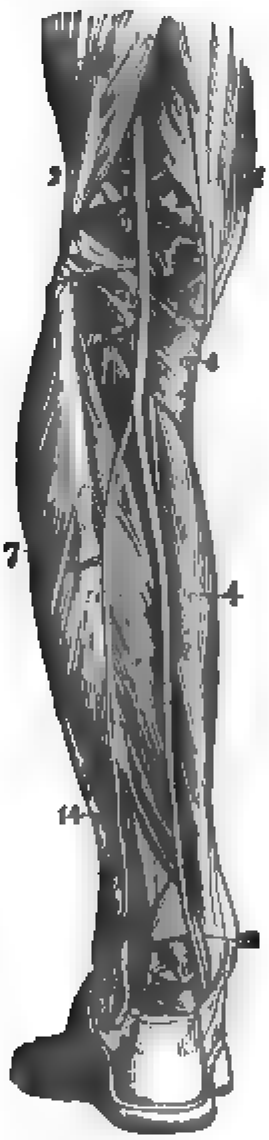
The *external circumflex*, which sometimes comes from the femoral, passes behind the sartorius and rectus muscles to the outer side of the thigh, where it divides into three sets of branches, a superior and middle, supplying the tensor vaginæ, gluteus medius, and anastomosing with the gluteal, ischiatic, and internal circumflex arteries; and a descending set, which go to the knee and anastomose with the external articular.

FIG. 257 represents the Femoral Artery with its branches. *a* to *b* Femoral artery. *c* Superficial epigastric. *d d* External pudics. *e e* Profunda femoris. *f* Internal circumflex. *g* External circumflex. *h h* Perforating arteries. *i* Epigastric. *j* Circumflexa ilii. *k* Muscular branches. *l* Superior internal articular. *m* Branch of the latter.

The *internal circumflex*, larger than the last, comes off below it, and sometimes from it. It passes deep between the psoas and pectineus muscles, and winds round the neck of the femur, supplying the hip joint and rotator muscles.

The perforating arteries are three or four in number, and named numerically first, second, third, and fourth. They perforate the adductor magnus, and are distributed to the muscles on the back of the thigh.

FIG. 258.



The *anastomotica magna* is the last branch of the femoral just at its termination; it descends to supply the parts about the knee, and to anastomose with the articular and long branches of the external circumflex.

Muscular branches are given off by the femoral through all its course.

THE POPLITEAL ARTERY.

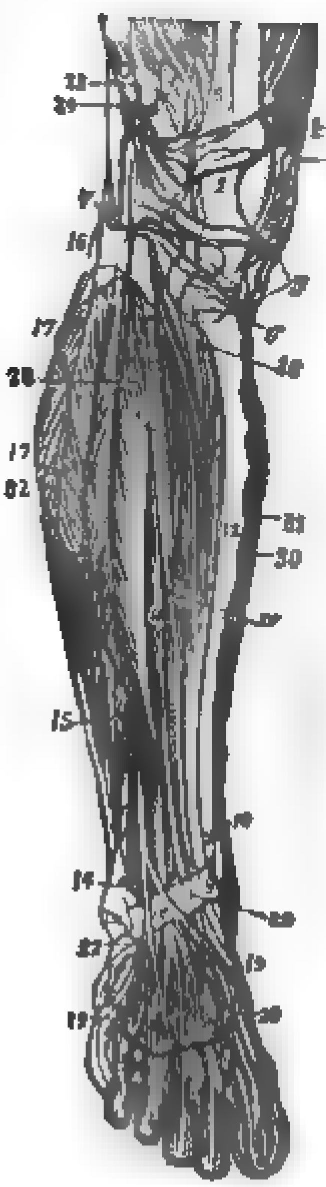
The *popliteal artery* extends from the opening in the tendon of the adductor magnus, to the opening in the interosseous ligament of the leg, and is a continuation of the femoral. Its course is obliquely outward to the centre and lower part of the popliteal space, situated between the outer and inner hamstring muscles, and imbedded in a quantity of adipose matter. Both the popliteal vein and nerve are superficial to the artery.

FIG. 258 represents the Popliteal and Posterior Tibial Artery. 1 Tendons forming the inner hamstring. 2 Tendon of outer hamstring. 3 Popliteus muscle. 4 Flexor longus digitorum. 5 Tibialis posticus. 6. Fibula. 7 Peroneii muscles. 8 Flexor longus pollicis. 9 Popliteal artery, which is seen to give off at its upper part two superior articular branches, the one external, the other internal; also two at its lower part, called inferior external and internal articular branches, with one in the centre—the middle articular. 10 Anterior tibial artery. 11 Posterior tibial artery. 12 Relation of artery with tendons at the ankle joint. 13 Peroneal artery. 14 Posterior peroneal branch.

BRANCHES OF THE POPLITEAL ARTERY, (Fig. 258.)

Muscular branches supplying the hamstring and gastrocnemius.

FIG. 259.



The *superior articular, external* and *internal*, wind round the condyles of the femur, supply the knee joint, and anastomose with the lower articular, the anastomotica, and the external circumflex arteries.

The *inferior articular* surround the lower part of the knee joint about the head of the tibia, and are also *external* and internal. They anastomose with the superior and anterior tibial recurrent.

The *middle articular* or *azygos* is the smallest of the articular branches, and pierces the posterior ligament to supply the synovial membrane of the joint.

The *sural* or *gastrocnemial* branches, two in number, go to the heads of the gastrocnemius. At the lower border of the popliteal space the popliteal artery divides into the *anterior* and *posterior tibial arteries*.

ANTERIOR TIBIAL ARTERY.

The *anterior tibial* passes through the opening of the interosseous liga-

FIG. 259 represents the anterior Tibial artery and Nerves of the Leg. 1 Patella. 2 Tendon of rectus muscle. 3 Vastus externus. 23 External cutaneous nerve. 24 Superior external articular artery. 4 Vastus internus muscle. 25 Superior internal articular artery. 5 Patellar branches of the saphenous nerve. 6 Inferior internal articular artery. 7 Inferior external articular artery. 8 Recurrent articular. 26 Tibialis anticus muscle. 9 9 Anterior tibial artery. 27 Anterior tibial nerve. 28 Extensor longus digitorum. 29 Anterior annular ligament. 11 Extensor proprius pollicis. 12 Tibia. 30 Internal saphenous vein. 31 Saphenous nerve. 13 Internal malleolar artery. 14 External malleolar artery. 15 Anterior peroneal artery. 16 External popliteal nerve. 17 17 Cutaneous branches of external popliteal nerve. 32 Gastrocnemius muscle. 18 Musculo-cutaneous nerve. 19 19 Venous arch on the dorsum of the foot. 20 Dorsalis pedis artery. 22 Tarsal artery.

ment, near the head of the fibula, and descends in front of the ligament, being deeply hid above by the tibialis anticus and extensor longus. At its lower part it is superficial, passing under the annular ligament and over the front of the ankle joint, where it can be felt pulsating, and runs to the base of the metatarsal bone of the great toe where it terminates. Two veins and the anterior tibial nerve accompany this artery.

BRANCHES OF THE ANTERIOR TIBIAL ARTERY.

The *recurrent* passes inward and upward around the knee joint, and anastomoses with the articular.

Muscular branches are given off all along the course of the artery to the muscles.

The *malleolar*, *external* and *internal*, go to the outer and inner side of the ankle joint.

The *tarsal* supply the tarsus.

The *metatarsal* gives branches to the tarsus, and supplies three of the outer interosseal spaces.

The *arteria pollicis* is the continued trunk of the anterior tibial, which runs along the back of the great toe, and sends a branch to the adjoining toe.

The *communicans* is another terminating branch of the anterior tibial, which descends between the two heads of the first dorsal interosseous muscle into the sole of the foot to anastomose with the external plantar artery.

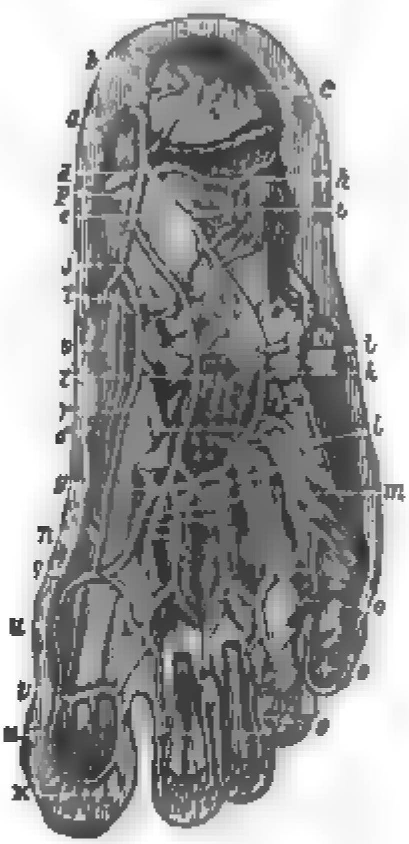
The *posterior tibial artery* (Fig. 258) forms the other terminating branch of the popliteal, and extends from the head of the tibia to the sinuosity of the os calcis. It descends the posterior part of the leg, covered by the gastrocnemius and soleus, and at its lower portion runs along the inner margin of the tendo-Achillis behind the malleolus internus. The posterior tibial nerve and two veins attend it.

BRANCHES OF THE POSTERIOR TIBIAL ARTERY.

The *peroneal artery* is the first branch of importance, and descends along the inner border of the fibula to the external ankle, supplying branches to the muscles in its

course, and dividing into the *anterior* and *posterior peroneal arteries*. The former gets through the interosseous ligament, about two inches above the ankle, and is distributed upon the upper external part of the foot; the latter supplies the heel and external ankle. *Muscular branches* are given off to the various muscles in its course.

FIG. 260.



The *nutritious artery* enters the nutritious foramen of the tibia.

The *plantar arteries* form the terminating branches, and are two in number.

The *external*, the larger of the plantar branches, passes outward and forward above the flexor brevis to the fifth metatarsal bone; from this it curves inward, across the foot, to the first metatarsal bone, forming the *arcus plantaris*, and ends by anastomosing with the anterior tibial. In its course the external plantar gives off the *perforating* branches, four in number, from its arch, which perforate as well as supply the interosseous muscles.

The *digital arteries* come also from the plantar arch, and after sending branches to the lumbricales and interossei, divide so as to supply the adjacent sides of contiguous toes. The artery of the little toe runs along its outer surface.

The *internal plantar* passes along the inner side of the

FIG. 260 represents the Arteries on the Sole of the Foot. *a* Posterior tibial artery. *b* Branches to the heel. *c* Branch of the posterior peroneal artery. *d* Point of division into external and internal plantar arteries. *e* External plantar. *f* Point where the external plantar begins to form its arch. *g* Anastomosis of anterior tibial with the plantar arch. *h i j* Muscular branches of external plantar. *k* Anastomosis of external plantar with the metatarsal artery. *l m* Digital branches to the little toe. *n* Digital branches to the other toes. *o o* Distribution of latter upon the toes. *p* Internal plantar artery. *q* Its anastomosis with the plantar arch. *r s t* Muscular branches of internal plantar. *u* Digital branch to the big toe. *v* Sub articular branch. *x* Anastomosis in the pulp of the toe.

sole of the foot, supplying the muscles of the great toe, and anastomosing with the digital arteries.

VEINS OF THE INFERIOR EXTREMITY.

FIG. 261.

The veins of the lower extremity, like those of the upper, are divided into the *superficial* and *deep*. The superficial veins are situated immediately beneath the skin, and consist of the *internal* and *external saphena*.

The *internal saphena* begins on the inner and upper part of the foot, ascends in front of the internal malleolus, along the inner portion of the leg to the inner condyle, behind which it passes; from this it still ascends along the inner and anterior part of the thigh to within two inches of Poupart's ligament, where it penetrates the fascia lata to join the femoral vein. In this course it receives numerous cutaneous veins, and at its termination is joined by the pudic, superficial epigastric, and superficial circumflex veins.

The *external saphena* begins at the outer ankle and dorsum of the foot, ascends on the back of the leg to the ham, where it joins the popliteal vein.

The *deep veins* accompanying the arteries have the same names, and are two for each artery, called venæ comites; hence we have *anterior, posterior tibial and peroneal veins*, uniting to form the *popliteal*, which is superficial to the artery. After traversing the popliteal space to the opening in the tendon of the adductor magnus, it changes its name to *femoral*. From this point the femoral, which is here on

FIG. 261 represents the Saphena Major Vein. *a* Superficial epigastric vein. *b* Internal pudic vein. *c* Superficial circumflex vein. *d* Origin of saphena major. *e* Its termination in the femoral vein.

the outside of the artery, gets behind it as it ascends, and at the upper part of the thigh is on the inner side. Having reached Poupart's ligament, it again changes its name, and becomes the *external iliac vein*, which will be found described along with the veins of the trunk. The popliteal receives, besides the external saphena, the articular veins of the knee joint. The femoral, besides the internal saphenus, receives the muscular veins and veins of the profunda.

SECTION IV.

NERVES OF THE INFERIOR EXTREMITY.

The *source* of nervous supply to the lower extremity *comes* from the *lumbar* and *sacral plexuses*. These plexuses (see Fig. 204) form two large nerves, the *anterior crural*, and *great sciatic*, the origin of which, together with the plexuses, are all described under the head of nerves of the chest and abdomen. The branches from the lumbar plexus which supply the upper part of the thigh, as the *musculo-cutaneous*, *genito crural*, *obturator*, and *anterior crural*, have also been described.

BRANCHES OF THE ANTERIOR CRURAL NERVE.

The *cutaneous branches*, four or five in number, pierce the fascia lata, and from their direction upon the skin, have been called the *middle*, *external*, *internal* and *anterior cutaneous nerves*. These principally supply the integuments on the anterior and inner part of the thigh, some descending as low as the knee.

Muscular Branches.—These are numerous to the various muscles on the front, inner and outer portions of the upper part of the thigh.

The *arterial branch* penetrates the sheath of the femoral vessels, and sends twigs which surround them.

The *internal saphenus* penetrates the sheath and accompanies the femoral artery to the opening in the adductor magnus. It here leaves the artery, and getting to the inner side of the knee, between the tendons of the sartorius and gracilis, joins the internal saphena vein, which it attends

to the inner side of the foot, supplying in its course the integuments of the leg. The internal saphenus communicates with the obturator, and the following branches are named as proceeding from it: A *femoral cutaneous* to the integuments of the inner and outer thigh; a *tibial cutaneous* going off a little above the inner condyle, and descending to supply the inner leg as low as the ankle; an *articular* branch to the knee joint, and an *anterior cutaneous*, given off near the inner condyle, to supply the parts about the patella.

FIG. 262.

BRANCHES OF THE SACRAL PLEXUS GOING TO THE THIGH, (Fig. 263.)

The *lesser sciatic* or *ischiatic nerve* comes out of the pelvis, below the pyriformis, in company with the ischiatic artery, and is divided into *muscular* and *cutaneous* branches. The muscular are called the *inferior gluteal nerves*, and go chiefly to the lower part of the gluteus maximus, some of the filaments being traced to the inner thigh and perineum.

Of the *cutaneous branches*, some go to the perineum and are called *perineal cutaneous*. A branch, called *posterior cutaneous*, is traced over the tuberosity of the ischium, and at the lower portion of the gluteus maximus, comes through the fascia and descends along the posterior and middle part of the thigh, and the popliteal space, as low down as the middle of the calf of the leg. In this course it gives

FIG. 262 represents the anterior Crural Nerve and its branches. *a* Point where the anterior crural emerges from beneath Poupart's ligament. *b* Division of the nerve into its branches. *c* Femoral artery. *d* Femoral vein. *e* Branches of obturator nerve. *f* Saphena nerve.

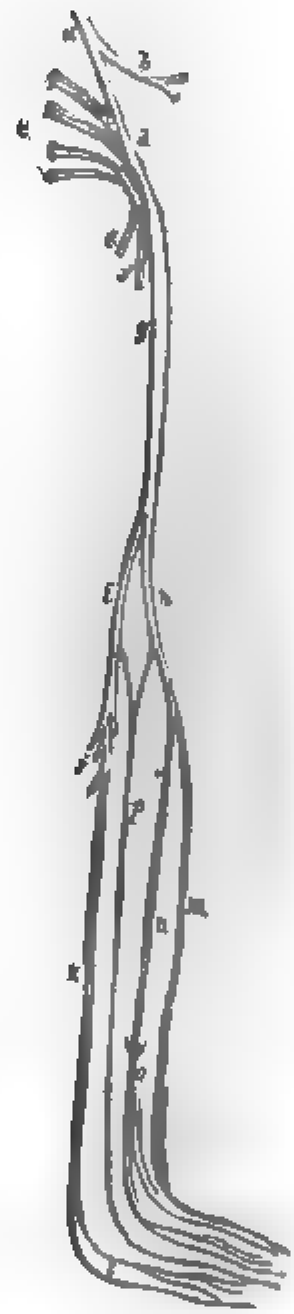
off many cutaneous branches to the posterior and lateral parts of the thigh, as well as a communicating branch in the ham, to the *external saphenus nerve.*

The *gluteal nerve* comes out of the pelvis, through the great sciatic foramen, along with the gluteal artery, and divides into a *superior branch,* which ascends to supply the gluteus medius and minimus muscles; and an *inferior branch,* which descends to supply, besides the glutei, the tensor vaginæ femoris.

The *internal pudic* and *obturator nerves* are described in another place.

The *great sciatic* or *posterior crural nerve* (Fig. 263) is the principal trunk from the sacral plexus, and the largest nerve of the body; it comes out of the pelvis through the larger sciatic foramen, below the pyriform muscle, sometimes through it; descends on the back of the thigh, about midway between the tuberosity of the ischium and trochanter major, over the small rotators, to about half way down the thigh, where it divides into the *popliteal* and *peroneal.* This division sometimes occurs as high as the pelvis at the plexus. Above it is concealed by the gluteus maximus, below by the hamstring muscles. The sciatic nerve gives off filaments to the hip joint, the various muscles in its course, and the integuments.

FIG. 263.



The *popliteal nerve* may be considered the continued trunk

FIG. 263 represents the Sacral Plexus and its branches. *a* Lumbo sacral nerve. *b* Gluteal nerve. *c* Anterior branches of the four upper sacral nerves. *d* Sacral plexus. *e* Internal pudic nerve. *f* Lesser sciatic nerve. *g* Great sciatic nerve. *h* External popliteal nerve. *i* Internal popliteal nerve. *j* Its branches to the calf of the leg. *k* Posterior tibial nerve. *l* Plantar nerves. *m* Anterior tibial nerve. *n* Musculo cutaneous nerve. *o* Its cutaneous portion. *p* External saphenus nerve.

of the great sciatic. It accompanies the popliteal artery between the heads of the gastrocnemius, to the lower border of the popliteus muscle, where it becomes the *posterior tibial nerve.*

BRANCHES OF THE POPLITEAL NERVE, (Fig. 263.)

External saphenus or *communicans tibiæ* comes off above the knee and descends the back part of the leg, beneath the fascia, to about half way between the knee and foot, where it emerges and becomes cutaneous, unites with a branch from the peroneal nerve, and is then traced in company with the external saphenus vein on the outer border of the tendo-Achillis to the back part of the external malleolus. It is distributed by numerous filaments to the integuments of the heel, sole, and outer margin of the foot and little toe, communicating likewise with the dorsal nerves of the foot.

Muscular branches are sent off to the gastrocnemius, soleus, plantaris and popliteus muscles.

Articular branches come off and go to the joint.

POSTERIOR TIBIAL NERVE, (Fig. 263.)

The *posterior tibial nerve* is a continuation of the popliteal, and accompanies the posterior tibial artery to the back part of the inner ankle, where it divides into the *internal* and *external plantar nerves.* The posterior tibial sends off in its course a few muscular branches, and a few cutaneous plantar branches.

The *internal plantar,* (Fig. 264,) larger than the external, goes along the inner side of the tarsus, giving filaments to the plantar muscles and integuments, and at the base of the great toe it divides into four *digital branches,* the first running along the tibial side of the great toe, and the other three subdividing so as to supply the opposing sides of all the rest except the little toe.

The *external plantar nerve* accompanies the external plantar artery to the fifth metatarsal bone, where it divides into two digital branches, one of which goes along the

outer side of the little toe, and the other divides so as to supply the opposing sides of the little and the fourth toe. The external plantar supplies the various muscles in its course, as well as the integuments on the outer margin and sole of the foot.

PERONEAL NERVE, (Fig 263.)

This nerve is the external popliteal, or second division of the great sciatic. It descends, along with the tendon of the biceps, to the head of the fibula, where it divides into the *anterior tibial* and *external peroneal* branches. Before this division it sends off two long branches, called the *external* and *internal peroneo-cutaneous nerve*, the former being distributed to the integuments along the fibula, the latter descending on the gastrocnemius, and about the middle of the leg uniting with the external saphenus or communicans tibiæ.

FIG. 264.

The *anterior tibial nerve* (Fig. 259) descends in front of the interosseous ligament, along with the anterior tibial vessels, to the ankle, where it passes under the annular ligament, and is distributed to the muscles and integuments on the dorsum of the foot and the two first toes; it supplies the various muscles in its course.

The *external peroneal* or *musculo-cutaneous nerve* (Fig. 259) descends the leg between the peroneus longus and extensor longus digitorum, and about the middle of the

FIG. 264 represents the Plantar Nerves. 1 Posterior tibial. 2 Abductor pollicis. 3 Flexor brevis digitorum. 4 4 Section of tendons of this latter muscle. 5 5 Abductor minimi digiti. 6 Musculus accessorius. 7 External plantar artery. 8 Internal plantar artery. 9 9 External plantar artery in the deep portion of the foot. 11 Point where external plantar artery gets to the dorsum of the foot. 12 Flexor longus pollicis. 13 Posterior tibial nerve. 14 Internal plantar nerve. 15 External plantar nerve. 16 Digital nerves.

leg it penetrates the fascia, and goes to the outer malleolus, where it divides into *external* and *internal branches*—the former supplying the integuments on the three outer toes, and connecting with the external saphenus; the latter being distributed on the two first toes, and communicating with the internal saphenus.

SUMMARY OF THE MUSCLES OF THE INFERIOR EXTREMITY.

MUSCLES OF THE THIGH.

ON THE FRONT.

Tensor vaginæ femoris.
Sartorius.
Rectus.
Vastus internus.
Vastus externus.
Crureus.

ON THE BACK.

Biceps.
Semitendinosus.
Semimembranosus.

INNER MUSCLES.

Iliacus internus.
Psoas magnus.
Pectineus.
Adductor longus.
Adductor brevis.
Adductor magnus.
Gracilis.

MUSCLES OF THE LEG.

ON THE FRONT.

Tibialis anticus.
Extensor longus digitorum.
Extensor longus pollicis.
Peroneus tertius.

ON THE OUTER LEG.

Peroneus longus.
Peroneus brevis.

ON THE BACK.

Gastrocnemius.
Plantáris.
Popliteus.
Flexor longus pollicis.
Flexor longus digitorum.
Tibialis posticus.

MUSCLES OF THE FOOT.

ON THE DORSUM.

Extensor brevis digitorum.
Interossei dorsales.

ON THE SOLE.

Abductor pollicis.
Flexor brevis digitorum.
Abductor minimi digiti.
Musculus accessorius.
Lumbricales.
Flexor brevis pollicis.
Adductor pollicis.
Flexor brevis minimi digiti.
Transervalis pedis.
Interossei plantares.

The muscles of the hip, which are most generally found among those of the lower extremities, will be found in the summary of the muscles of the trunk.

ANATOMICAL AND PHYSIOLOGICAL RELATIONS OF THE MOUTH WITH THE EXTREMITIES.

Under this head we shall only refer to the well known pathological fact of trismus or locked-jaw resulting from injury to the toes, thus establishing a relation between the mouth and inferior extremities. This relation, in all probability, occurs through the spinal marrow and fifth pair of nerves.

The relations of the mouth with the superior extremities are, no doubt, equally close and important with those of the inferior extremities.

THE END.

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